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CONTENTS

Volume VIII. DECEMBER. 1931 Number XII.

THE HIBBARD CONTROL SYSTEM AND ITS APPLICATION TO SYNCHRONOUS MOTORS IN STEEL MILLS—By W. H. Feldmann and S. P. Bordeau, Electric Machinery Mfg. Co., Minneapolis, Minn. 483

DISCUSSION—THE HIBBARD CONTROL SYSTEM AND ITS APPLICATION TO SYNCHRONOUS MOTORS IN STEEL MILLS—Discussion Presented by W. H. Feldmann, J. J. Booth, S. L. Henderson, J. D. Donovan, O. C. Callow, S. N. Roberts, A. L. Reichert, F. W. Cramer, J. Farrington, F. O. Schnure, R. W. Davis 491

THE METALLIC CHARGE IN BASIC OPEN HEARTH OPERATIONS—SOME FACTORS AFFECTING OPERATING ECONOMIES—By Clarence D. King, Chairman, Open Hearth Committee, U. S. Steel Corporation, New York, N. Y. 493

DYNAMIC PROPERTIES OF ARC WELDED JOINTS—By C. H. Jennings, Research Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 498

THE APPLICATION OF HEALTH LAMPS TO THE IRON AND STEEL INDUSTRY WITH RELATION TO HEALTH AND EFFICIENCY—By M. J. Dorcas, National Carbon Co., Cleveland, Ohio 501

DISCUSSION—TWIN MOTOR DRIVE—Discussion Presented by J. H. Van Campen, R. H. Wright, G. R. Carroll, W. B. Shirk 503

THE TESTING OF LUBRICANTS—By E. S. Glauch, Mechanical Engineer, Joseph Dixon Crucible Co., Jersey City, N. J. 504

A PRACTICAL SALES POLICY—By R. D. Wood, Mississippi Valley Structural Steel Company 508

GOOD HOUSEKEEPING—By A. V. Berquist, Safety Inspector, Youngstown Sheet and Tube Co., East Chicago, Ind. 509

HAND LABOR AND TRUCKING—By J. A. Voss, Safety Director, Republic Steel Corp., Youngstown, Ohio 512

ITEMS OF INTEREST 513

COMING MEETINGS AND PAPERS II

EDITORIAL III

INDEX TO ADVERTISERS IV

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Coming Meetings and Papers

E. C. MARSHALL,

Chairman, Chicago Section,

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CHICAGO SECTION, January 19, 1932. "THE CURRENT COLLECTING PROBLEM," by C. Lynn, Design Engineer, Westinghouse Electric & Mfg. Co.

W. H. GILBERT,

Chairman, Birmingham Section,

Asst. Mech. Engr., Tenn. Coal, Iron & R. R. Co., Birmingham, Ala.

BIRMINGHAM SECTION, subjects announced later. Meetings held last Saturday of month at Thomas Jefferson Hotel, Birmingham, Ala.

H. D. ESTERLY,

Chairman, Philadelphia Section,

Elec. Supt., Alan Wood Steel Co., Conshohocken, Pa.

PHILADELPHIA SECTION, Saturday, January 9, 1932. "MAGNETIC TESTING OF STEEL PRODUCTS," by Alfred V. de Forest, Research Engineer, American Chain Co., Bridgeport, Conn.

A. L. FOELL,

Chairman, Cleveland Section,

Chief Engr., Arthur G. McKee Co., Cleveland, Ohio

CLEVELAND SECTION, February 5, 1932. "SPECIAL MOTORS FOR QUICK STARTING AND STOPPING AND RAPID REVERSALS."

R. F. SANNER,

Chairman, Pittsburgh Section,

Asst. Elec. Engineer, Carnegie Steel Co., Duquesne, Pa.

PITTSBURGH SECTION, January 9, 1932. "ASBESTOS IN INDUSTRIAL FRICTION MATERIALS," by J. W. Hemphill, Jr., Power Products Dept., Johns-Manville Co., New York, N. Y.

EDITORIAL

The Application of The Photo-Electric Relay In Steel Mills

A few short years ago radio was only an interesting toy, today it is one of our great industries and exerts a tremendous influence on our every day life. The development of the vacuum tube to its present high degree of usefulness has been the prime reason for this great advance in so short a time.

The vacuum tube has now entered industry. Not the radio tube, but tubes with various modifications to suit the particular applications are being used. When the use of the vacuum tubes were first considered for steel mills, the plant engineers were of the opinion that these tubes were too fragile to survive under the operating conditions that would be encountered. The results of the first few installations substantiated this opinion, but it was also learned that this difficulty could be overcome by improving tube mounting and properly locating and shielding the equipment. The benefits to be gained from further applications were readily apparent, so much so that in the past several years the use of vacuum tubes in steel mills has made tremendous strides. Many of us may not remember that only three years ago few steel mill men had seen a single application of a vacuum tube, photo-electric cell, or thyratron to a production problem, while today the applications are quite numerous. Some of the already tried applications are:—flag switches, contactors, and relays to control welding, voltage regulation, automatic lighting and dimming, smoke detection, traffic light control, automatic screwdowns, automatic operators for soaking pit covers, level indicators, safety devices on equipment such as shears, cutting material to length, sorting material as to color or gauge, counting, generator and motor flashover protection, detection of broken containers, long distance metering, power demand limiters, and power rectifiers.

Other important fields of application include the use of these devices as radiant pyrometers, and for automatically controlling the tension of cold rolled strip, by changing motor speeds. The use of thyratrons for this purpose is so simple as to lend itself to a multitude of uses involving variation in motor speeds, by field or armature control, to secure automatic regulation of pressures and temperatures.

The applications using photo-electric relays ordinarily utilize their ability to distinguish changes in light intensity. In these applications an object intercepting a beam of light actuates the relay. Applications of thyratrons, grid-glow, and other types of tubes utilize other characteristics such as instantaneous relay action to control as much as 5,000 times as much current as flows in the control circuit.

Considering the progress made during the past several years in the use of vacuum tubes in steel mills it seems reasonable to expect that in the next decade the use of vacuum and gas filled tubes will have a multitude of uses. Especially, since the vacuum tube has no practical frequency limitation, is almost instantaneous in its response, and will permit continuous control of its power output. This last characteristic permits a smooth increase in current output, so that these devices can be used as relays or contactors to secure a smooth motor acceleration along any desired speed curve. At present the cost of such an installation is higher than for contactors of similar rating but even now, where the speed of opening and closing the circuit makes the use of contactors impractical or undesirable, vacuum (or gas filled) tubes are used with great success, such as in interrupted welding.

The use of tubes on such a large scale may seem to be many years in the future but worth while developments come rapidly once they get under way. This was clearly shown in the development of the current relay for motor acceleration. Less than twenty years ago the electrical engineers of the steel industry first saw a current relay at a meeting of the Association in a Pittsburgh hotel and questioned if it could be successfully used for accelerating motors. Its use for such work is now commonplace. The vacuum tube in the steel mill may be just as commonplace in an unbelievable short time.

However, if such rapid progress is to be made without undue cost, caution must be observed along several lines. Operating engineers should guard against misapplication or enthusiasm will be burned out in overcoming the difficulties met. The manufacturers are familiar with the possibilities and limitations of the tubes they manufacture; the steel mill engineers are, or soon will be, familiar with the practical difficulties to be encountered. To overcome these difficulties it will be necessary to know many details of the design of the tubes, and for this reason a solution will be obtained much more quickly if the manufacturers and the plant engineers work together. The Association hopes to be able to help bring this about in its future meetings.

Many applications have been made without consulting the tube manufacturer and much grief has resulted that could have been avoided if the manufacturer had been asked to assist in the application. Perhaps the best practical solution is for each plant to examine and try out one of these devices on several jobs in order to become familiar with the characteristics and limitations of the tubes.

Undoubtedly many phases of steel mill practices can be materially improved and simplified by the use of photo-electric relays. When searching for possible applications it should be kept in mind that shortly, radical improvements in the devices themselves can be expected and with these improvements more fields of application will result.

INDEX TO ADVERTISERS

A

The Aetna-Standard Engineering Co. 520-21
The Alliance Machine Co. 564
Allis-Chalmers Manufacturing Company 566

B

The Baker-Raulang Company 541
The Bantam Ball Bearing Company 554
The Bartlett Hayward Co. 568
E. W. Bliss Co. 532
S. F. Bowser & Co., Inc. 570
The Bristol Company 537
Bull Dog Electric Products Company 515

C

Century Electric Company 535
The Clark Controller Co. 561
The Cleveland Crane & Engineering Co. 539-40
Crocker-Wheeler Electric Mfg. Co. 543
Crouse-Hinds Company 553
Cutler-Hammer, Inc. 549
Colt's Patent Fire Arms Mfg. Co. 546

D

Joseph Dixon Crucible Company 564
Doubleday-Hill Electric Company 563

E

The Electric Controller & Mfg. Co. 523
Electric Machinery Mfg. Co. 527
Electro Dynamic Co. 552
Electrical Engineers Equipment Co. 561
Elliott Company 516

F

Farrel-Birmingham Co., Inc. 536

G

General Electric Company Cover 4

H

Hyatt Roller Bearing Co. 548

I

I. T. E. Circuit Breaker Co. Cover 3

J

Jefferson Electric Company 538
Jewell Electrical Instrument Company 556

K

Keystone Lubricating Co. 522

L

Le Carbone Co. 559

M

Mantle Engineering Co. 547
The Martindale Electric Co. 560
Morgan Construction Company 567
The Morgan Engineering Company Cover 1-550
Morganite Brush Co., Inc. 558

N

National Carbon Company Inc. 529
The New Departure Mfg. Co. 542
The Nichols-Lintern Company 534
Norma-Hoffmann Bearings Corporation 569

O

The Ohio Electric Mfg. Co. 571
The Okonite Company 545

P

Pennsylvania Transformer Co. 559

R

Railway and Industrial Engineering Co. 563
The Reliance Electric & Engineering Co. 572
Rockbestos Products Corporation 558
The Rowan Controller Co. 557

S

Schloemann Engineering Company 555
Shepard Niles Crane & Hoist Corporation 528
S. K. F. Industries, Inc. 533
Stimple & Ward Co. Inc. 560
Surface Combustion Corporation 530-31-547
Sundh Electric Co. 561

T

The Thompson Electric Company 562
The Timken Roller Bearing Company 524-25
The Tool Steel Gear & Pinion Co. 526
Turner Engineering Company 518-19
Trico Fuse Mfg. Co. 565
The Trumbull Electric Manufacturing Co. 517

U

Union Carbide and Carbon Corporation 529
The United States Graphite Company 562

W

The Wellman Engineering Co. 551
Westinghouse Electric & Mfg. Co. Cover 2
Edwin L. Wiegand Company 544

The Hibbard Control System and Its Application To Synchronous Motors In Steel Mills†

By W. H. FELDMANN* and S. P. BORDEAU*

The recent remarkable increase in the use of synchronous motors in steel mills has made their characteristics, operation and control, subjects of considerable interest to steel mill engineers. Of particular interest is synchronous motor control equipment which will provide better motor starting and operation, and which will completely protect the motor from any critically abnormal line or load condition.

There are several important reasons for the recent widespread application of synchronous motors in steel mills, some of which are:

1. The synchronous motor operates at unity or leading power factor at full load, and at part load its power factor is always leading. The synchronous motor thus contributes to high mill power factor, affording direct economies by permitting reduction in the size of generating and distribution equipment, or in preventing power factor penalties where power is purchased.
2. The synchronous motor efficiency is relatively high regardless of its speed rating. Its efficiency is usually from 1 to 2 percent higher than the induction motor of equivalent horsepower in the usual induction motor speed ratings. The efficiency curve of a synchronous motor is comparatively flat, and at 10 per cent load may be 75 percent to 80 percent, which is much higher than is obtainable with the corresponding induction motor.
3. Because of their high operating efficiency at slow speeds synchronous motors can be applied directly to slow speed drives, often eliminating part or all of the mechanical speed reducing equipment required for the drive.
4. The first cost of the synchronous motor in higher speeds compares favorably with that of induction motors. In slow speeds its first cost is appreciably lower.
5. The synchronous motor is characterized by great robustness, making it less liable to breakdown. And, when breakdown does occur, the motor is easily repaired. In comparison with the wound-rotor induction motor, the synchronous motor has fewer stator coils, permitting the motor to be more easily designed for high voltages, and making stator repair a simpler job. The rotor winding is also simple and less likely to trouble. The air-gap between rotor and stator on the synchronous motor is comparatively large, minimizing the possibility of trouble from bearing wear and misadjustment.
6. The absolutely constant speed of the synchronous motor is an important advantage on those drives where quantity and quality of product and constant output are dependent on unvarying speed.

As a result of these desirable characteristics, within the last ten years the use of synchronous motors on steel mill auxiliary equipment, and, more recently, on main roll drives, has increased tremendously. Since 1927 initial installations of synchronous motors totalling over 250,000 horsepower, in nominal ratings ranging from 300 horsepower to 9000 horsepower have been made to various types of main-roll drives alone. The synchronous motor has proved to be superior to the induction motor, and on many types of steel mill drives will no doubt largely replace it.

Synchronous motors usually offer the best solution economically for the following specific drives found in steel mills:

Air and Gas Compressors
Centrifugal Pumps
Reciprocating Pumps
Blowers
Fans
Gas Washers
Motor Generator Drives
Practically all Constant Speed Main Roll Drives.

The favorable status of the modern synchronous motor was not achieved, however, until several definite limitations of the earlier synchronous motors were overcome. In fact, the early limitations of synchronous motors and their control, and the little attention paid to high power factor, retarded for many years the widespread application of synchronous motors to steel mill drives. Modern designs and construction have removed most of the early synchronous motor limitations. And much attention is now paid to maintenance of high power factor mill operation to permit lowest power cost and better voltage regulation. It will be remembered that the earlier direct current and induction motors also went through a similar period of redesign and reconstruction before they became generally accepted.

The improvement that has been made in the starting torque characteristics of synchronous motors will be a surprise to many engineers who have felt that lack of suitable starting characteristics was a serious drawback to their use. Starting, pull-in, and pull-out torques suitable to meet the requirements of practically any drive can now be supplied. Hence there are now almost no limitations to the use of synchronous motor drives due to inability to start the load, or to lack of stability in operation.

Ratio of torque to kv-a. during the starting period has been considerably increased in modern synchronous motors. Starting power factors now obtain-

* Electric Machinery Mfg. Company, Minneapolis, Minn.
† Presented before the Twenty-seventh Annual A. I. & S. E. E. Convention, June 17, 1931 at Cleveland, Ohio.

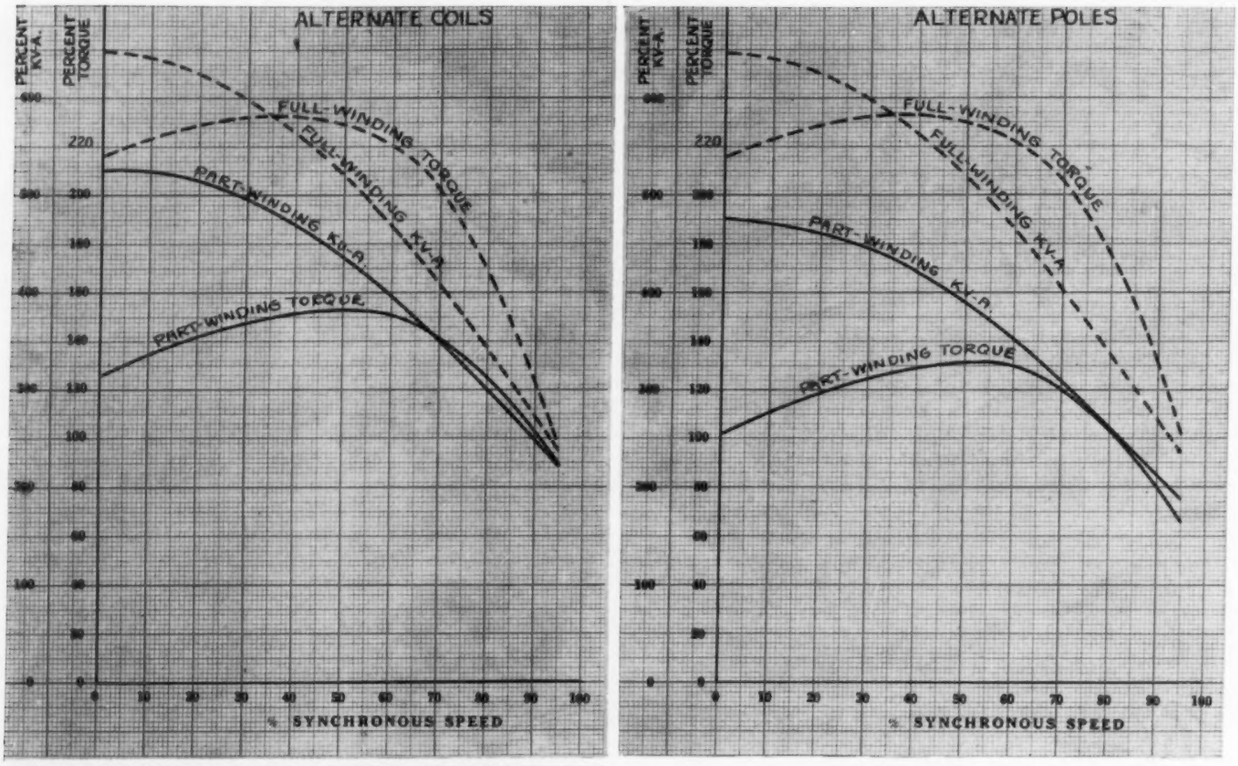


Fig. 1.—Curves illustrating the effect on starting KV-A. and torque of various arrangements of stator parallel circuits used in part-winding starting.

able range from approximately 20% to 45%. With the large power systems used in steel mills, the relatively high kv-a. taken by synchronous motors as compared to wound-rotor induction motors during the starting period, is no drawback to their use.

The early limitation of totally inadequate control equipment resulted in difficulty in starting with unskilled operators, and stoppages due to load peaks and momentary power disturbances. These limitations have been entirely removed by the recently developed Hibbard Control System, which provides a complete, simple, and extremely reliable control for synchronous motor drives. It is the object of this paper to describe the control features offered in the Hibbard Control System.

REQUIREMENTS OF SYNCHRONOUS MOTOR CONTROL

It is a fact well recognized that a motor is no more reliable than its control. This is particularly true of the synchronous motor where the starting operation must be interlocked with motor speed to secure proper starting characteristics, or to start the motor at all. The power factor of the synchronous motor during the starting period, as has been previously mentioned, is from 20 to 45%. These low power factors are due largely to the magnetizing current required for the air gap. With these low power factors, starting kv-a. per unit of torque is high (approximately as for a squirrel-cage induction motor), and it is a matter of some importance to secure a minimum amount of disturbance on the power system from which the motor is being started. Full voltage starting, because of its simplicity, should be used wherever the power system is large enough to provide the starting kv-a. without excessive voltage drop, or where full voltage starting torques are required. Where starting kv-a. must be limited, some means of reducing the kv-a. inrush should be used, the motor being started with reduced kv-a. and

later in the starting period transferred to full kv-a. The point of transfer should be made at a motor speed which will make the line disturbance a minimum. The starting operation of the synchronous motor should be completed at pull-in speed, i.e., approximately 95% synchronous speed, by the application of direct current excitation of suitable value to the motor field. It is important for successful motor starting that the motor field excitation be applied at the correct motor speed for synchronizing. It is very desirable also that automatic removal of field excitation be provided so that the motor is permitted to automatically resynchronize whenever it is pulled out of synchronous speed.

The Hibbard Control System was developed to meet the obvious need for a complete synchronous motor control system which will automatically start the motor under the best conditions, in the shortest time, everytime, and keep it in successful operation during momentary power or load disturbances.

The complete system comprises the following separate features:

1. Part-winding, reduced-kv-a. starting.
2. Transfer to full kv-a. by means responsive to the electrical condition of the field winding (Frequency Relay FR-1).
3. Synchronizing by means responsive to the electrical condition of the field winding (Frequency Relay FR-2).
4. Delayed low voltage release.
5. Field kick-off and resynchronizing (where the load permits).
6. Unloading and reapplication of load to driven machine.

Not all of these features are required for every application, but those are employed that accomplish *best possible starting under all conditions and continuous operation through momentary power or load disturbances.*

This complete Control System is the culmination of developments in automatic control for synchronous motors which started in 1917, and are just now reaching completion. Some of the parts of the system have been available for many years. Field responsive synchronizing, for example, has been proved in service to be the correct method. The availability of the completed system, however, has waited on the development of part-winding starting, delayed low voltage release, and some unloader devices which have only recently been completed.

A detailed description of the component parts of this Control System and some considerations that dictate their use are now given in the order of sequence of operation.

PART-WINDING, REDUCED-KV-A. STARTING

In many cases where full kv-a. starting is not to be preferred, *part-winding, reduced-kv-a. starting* has advantages over other forms. This starting method, where motor winding can be adapted to it, replaces reduced-voltage starting employing auto-transformer, reactor, or resistance starting.

With the part-winding, reduced-kv-a. starting method, the motor stator is divided into two or more parallel circuits; one of the circuits is connected to the full line voltage at standstill, the other or others connected to the line at a later time during the starting period. This novel starting method, first developed by Electric Machinery Mfg. Company, is based on the discovery that when only one of two parallel, properly distributed stator circuits is connected to full line voltage the impedance of this winding is considerably greater than that of the two windings in parallel, resulting in lower starting kv-a. and torque.

The effective impedance can be varied to some extent by the arrangement of the windings with respect to the magnetic circuits in the stator core giving various values of starting kv-a. and torque. (See Figure 1). Two possible parallel circuit arrangements are shown in Figures 1a and 1b. With this new starting method similar results are obtained as when starting with a series reactor to reduce the voltage on the motor. Depending on the design of the particular motor involved, i.e., the arrangement

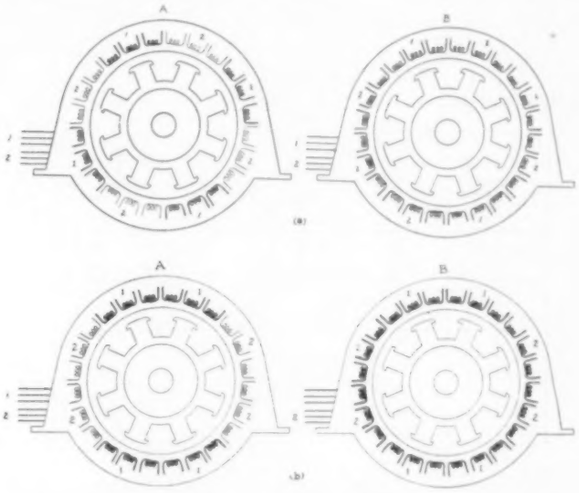


Fig. 1a and 1b.—Schematic diagrams illustrating part-winding operation.

of the coil groups, the use of one circuit of a two-circuit winding gives ordinarily from 56% to 72% of normal starting torque and a somewhat higher percent kv-a.

This starting method has the disadvantage of requiring installation of six primary leads from the motor stator to control switches for a three-phase

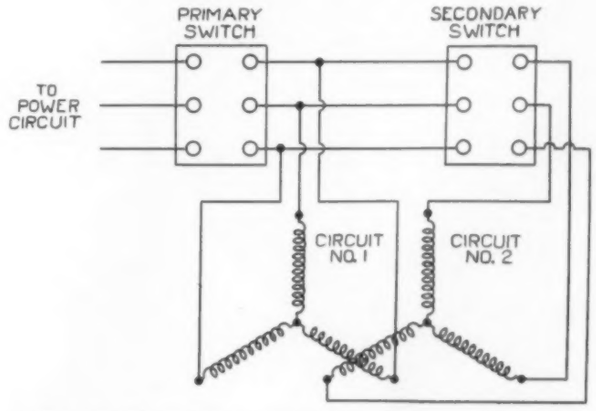


Fig. 2.—Elementary connection diagram showing switching means employed for part-winding starting.

motor. Additional sets of leads are required for motors using more than two circuits.

The greater number of turns per coil required for this starting method limit, to some degree, the smaller horsepowers to which it can be applied at higher voltages. Speed limitations are practically of no consequence. Operating characteristics of the motor, such as efficiency and power factor, are not materially affected by parallel circuit construction.

Control

The control for part-winding starting consists of a primary 3 PST line switch which opens both circuits in event of overload or short circuit; a secondary 3 PST switch for connection of the second parallel circuit, frequency relay (FR-1) to actuate the secondary switch, field contactor and its operating frequency relay (FR-2). An elementary connection diagram of stator connections and switches is shown in Figure 2. It is evident that closing the primary switch will connect circuit No. 1 to the line. Closing the secondary switch will connect circuit No. 2 to the line in parallel with circuit No. 1 and on the motor side of the primary switch.

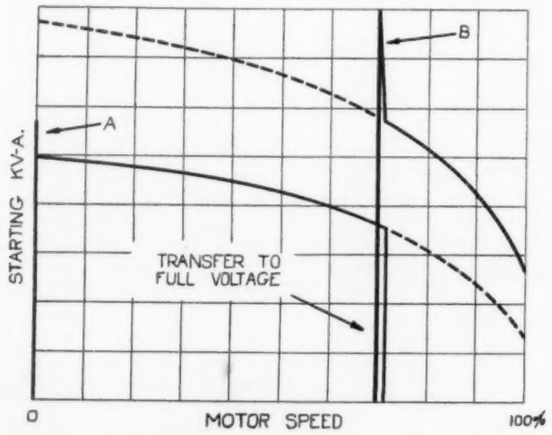


Fig. 3.—Starting KV-A. curve for reduced voltage starting using an auto-transformer.

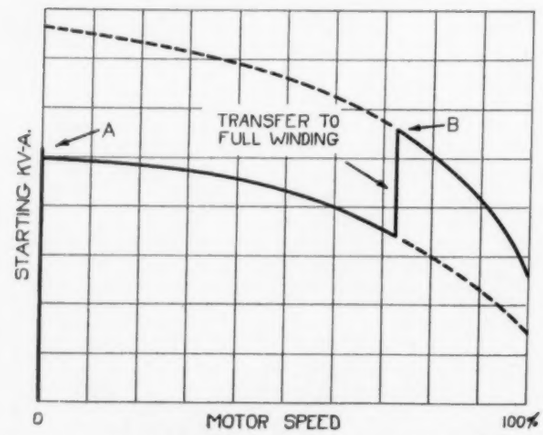


Fig. 4.—Starting KV-A. curve for part-winding starting using two parallel circuits in the motor.

Advantages

The advantages realized by this method of starting as compared to the reduced voltage methods using auto-transformer or reactors are as follows:

1. Less momentary line disturbance at starting due to elimination of auto-transformer or reactor magnetizing current. See point A of Figures 3, 4, 5 and 6, for the auto-transformer.
2. Greatly lessened disturbance at "transfer" as compared to auto-transformer starting because the motor is not disconnected from and reconnected to the line. See point B of Figures 3, 4, 5 and 6. In part-winding starting the stator of the motor is partially magnetized after the first circuit has been connected to the line; connecting the second half of the stator circuit to the line merely completes the magnetization of the stator and there is no high surge of magnetizing current. With auto-transformer starting, however, the complete breaking of the stator circuit at transfer makes necessary the entire remagnetization of the stator core.
3. Higher torque per kv-a. ratio than can usually be obtained with reactor starting, permitting less kv-a. line inrush per unit of torque in starting.

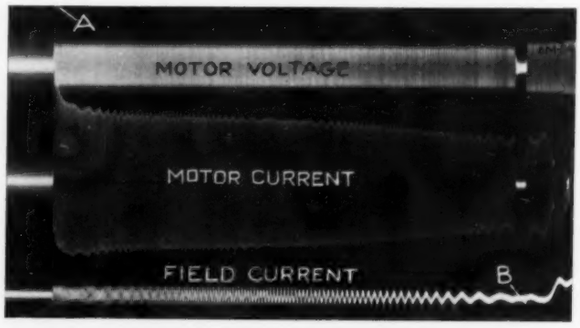


Fig. 5.—Oscillogram showing motor voltage, motor current and field current for reduced-voltage starting using an auto-transformer

4. A simpler starter due to elimination of auto-transformer and magnetizing switch, or reactor.
5. Less maintenance due to less equipment and elimination of possibility of short circuiting auto-transformer by getting both switches closed at one time.

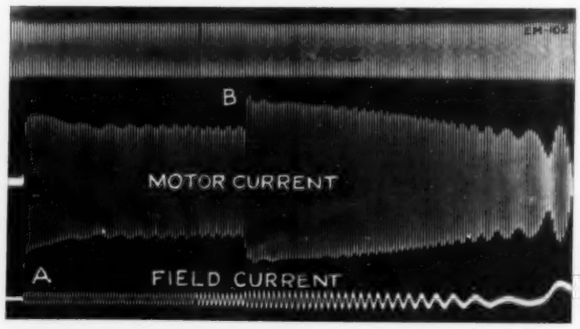


Fig. 6.—Oscillogram of part-winding starting showing motor voltage, motor current and field current.

6. Availability of "increment" starting giving small steps in starting kv-a. and without opening the primary connections, by switching successively two or more circuits to the line. (See Figure 7).

7. Where pull-in torque requirements are low and low current inrush at starting critical, the motor can be synchronized on the first winding

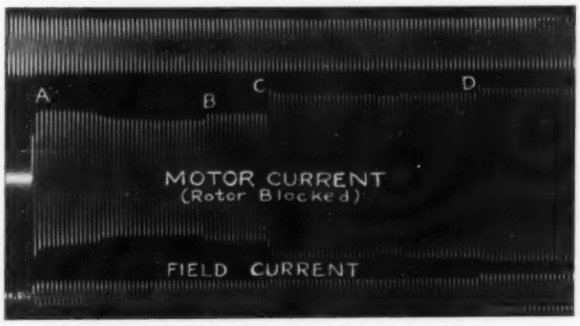


Fig. 7.—Oscillogram showing part-winding, reduced KV-A. "leg" starting.

and the second winding connected after synchronism (by substituting a suitable transfer relay for FR-1).

Part-winding starting can be used to advantage on steel mill motors wherever reduced kv-a. inrush is necessary or desirable. High speed motors where the high kv-a. which would result from full-voltage starting is not permissible or large main-roll motors where full-voltage starting torque is not necessary or where reduction in starting kv-a. is required can, for example, use this form of starting with material improvement and simplification in the starting system.

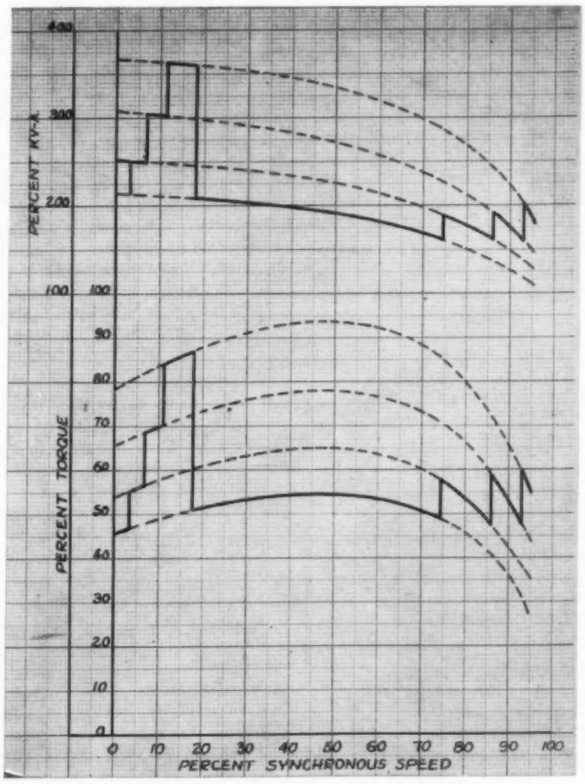


Fig. 8.—Starting KV-A. and torque curves illustrating torque increments obtainable with part-winding starting.

Cold-roll sheet mill synchronous motors are usually started on full voltage because of their high starting torque requirements, especially in cold weather. Where reduced current inrush in starting is preferred on this drive, part-winding starting can be used to advantage. The starting torque obtainable with the single circuit of a double circuit motor with part-winding starting would suffice in the majority of cases to successfully start the mill. Hence starting kv-a. would be reduced in the majority of cases. To provide for those instances where a high torque is necessary to start the mill, a balance-frequency relay is supplied. This relay will automatically switch on the second circuit of the motor and give the equivalent of full-voltage starting should the motor not be able to start the mill, (See Figure 8). After break-away is accomplished, the mill is accelerated on part-winding, thus minimizing disturbance to the power system.

The acceleration period of gas washers (disintegrators) must usually be stretched out to from 40 to 70 seconds to avoid injury to the washer from too rapid acceleration. This comparatively long acceleration period has been accomplished very successfully by means of part-winding starting, employing a two-circuit synchronous motor.

An interesting instance of the use of the part-winding reduced-kv-a. starting principle is the case of a recent synchronous motor installation for continuous reversing duty on a hot copper rolling mill. The motor was provided with three parallel circuits and used three two-pole switches for forward rotation and a duplicate set for reversing. This permitted building up the total current in small increments, and permitted use of lighter switches. Figure 9 shows an oscillogram of the reversing operation.

Fig. 9.—Oscillogram of reversing period of synchronous motor driving reversing copper mill. Motor current curve shows how three-circuit part-winding is used

TRANSFER BY FIELD-RESPONSIVE CONDITION

Wherever reduced-kv-a. starting is required this Control System provides positive transfer from reduced kv-a. to full kv-a. by the FR-1 transfer relay. The FR-1 relay which is used on reduced-voltage starters to transfer to full voltage is used similarly on part-winding starters to transfer from reduced kv-a. to full kv-a. In cases where power line conditions or drive conditions are critical, proper adjustment of FR-1 relay will insure transfer at a point of the starting kv-a. curve that will cause a minimum disturbance *every* time the motor starts.

It has long been known that the current set up by the voltage that is induced in the rotor of an alternating current motor varies in frequency directly as the rotor slip, or inversely as the motor speed. That is, assuming that a sixty cycle source

of power is applied to the stator winding, the frequency of the rotor current is 60 cycles at standstill,

Fig. 10.—An oscillogram showing decline of frequency in the rotor circuit of a synchronous motor during the starting period.

30 cycles at half speed, and zero cycles at full or synchronous speed. (See the oscillograph record, Figure 10). This very accurate measure of motor speed is utilized to operate the control steps.

For reduced-voltage or part-winding forms of automatic starters, there are two frequency relays that are operated by the decline in frequency in the

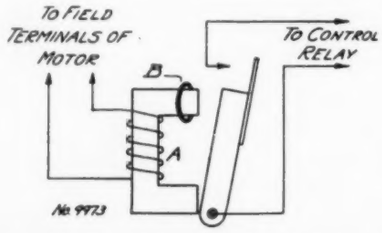


Fig. 11.—Diagram illustrating principle of operation of frequency relay FR-1.

rotor circuit during starting. Frequency relay FR-1 transfers the motor from reduced to full voltage, or reduced kv-a. to full kv-a., and frequency relay FR-2 closes the field contactor, thus applying direct current excitation to the motor. Full-voltage type starters require only the second operation.

The diagram shown in Figure 11 illustrates the theory of operation of FR-1. As has been pointed out and as shown by the oscillogram in Figure 10 (Point A), an alternating current of 60 cycles frequency (in the case of a 60-cycle motor) flows through the coil A when the motor is first started on reduced-voltage or part-winding. This current would immediately close the relay except for the influence of the copper damping ring B. The alternating magnetic field set up by the current in coil A generates a voltage in the damping ring B, which in turn causes a current to flow and a magnetic field to be set up which opposes the magnetic field set up by the current in coil A. As long as the frequency of the current flowing through coil A is high, the opposition of damping ring B is sufficient to prevent the relay from closing against a spring tension. When, however, the frequency declines to a sufficiently low value, the opposing effect of the damping ring B falls off sufficiently to permit the relay to close. The closing of this relay is adjustable between 40% and 90% of motor speed, or 36 cycles (B) to 6 cycles (C) rotor frequency (see Figure 10), by a simple adjustment of air gap and spring tension. When once set it will always close at the same motor speed which can be determined as that best suited for transfer from reduced to full voltage for the particular application under control.

SYNCHRONIZING BY FIELD-RESPONSIVE CONDITION

As has been previously pointed out, it is important for proper synchronous motor starting that operation of the synchronizing relay be interlocked with motor speed. This is accomplished in this Control System by synchronizing relay FR-2. Because its operation is interlocked with motor speed FR-2 always applies field excitation to the motor at the correct speed for synchronizing, independent of load conditions or the time required for the motor to accelerate.

On many steel mill applications, main-roll drives in particular, the time required for the motor to accelerate its load to the pull-in speed varies appreciably, due largely to variation in viscosity of the lubricating oils and greases with differences in temperature, or to variations in voltage at the motor terminals.

This variable time factor in starting is of no consequence in affecting proper synchronizing where the field-frequency-responsive synchronizing relay is used. Synchronizing is accomplished neither too soon nor too late.

Like transfer relay FR-1, FR-2 is also adjustable, but over a much smaller range. Its operation can best be understood by referring to Figure 12. During the entire starting period, a current of declining frequency is flowing through the closed field circuit made up of the field winding, reactor X, field discharge clip 6, and field discharge resistor FDR. Shunted across the reactor X is the frequency relay FR-2. As the reactor has a very low resistance and high reactance at high frequency, a large amount of the current will be caused to flow through the FR-2 coil at starting. This results in the relay closing immediately upon the application of power to the stator winding of the motor. When the frequency of the rotor current declines to a predetermined value,—usually 3 cycles (see point D of Figure 10) corresponding to 95% motor speed the relay opens and thus closes the field contactor FC. This relay is extremely accurate, and when once set will always apply excitation at the correct motor speed for the application under consideration. The relay is adjustable and can be set to apply excitation to the

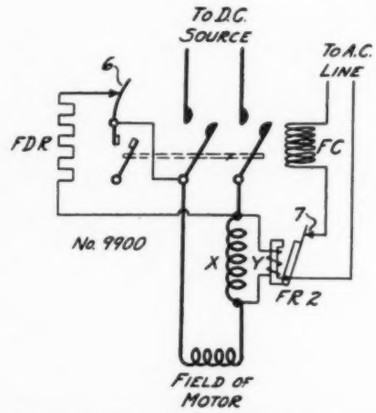


Fig. 12.—Diagram illustrating principle of operation of frequency relay FR-2.

motor at any fixed point between 92% and 98% synchronous speed. This range of speed settings

for synchronizing has proved to be ample for all synchronous motor applications.

While it is true that the speed for synchronizing will vary somewhat with the loading and with motor design, there is no object in a FR-2 setting below 92% speed, since the motor would not pull into step if excitation were applied at a speed as low as, say, 90%. Lightly loaded synchronous motors will synchronize if excitation is applied at, say, 90% speed, but under such conditions the motor will readily accelerate to at least 95% speed, and at that speed excitation will be applied by FR-2 to give minimum line disturbance.

KICK-OFF AND RESYNCHRONIZING

By "kick-off" is meant the removal of field excitation when, for any reason, the motor is out of step. An important feature of this Control System is that the FR-2 synchronizing relay provides for automatically removing excitation if the motor should, for any reason, get out of step.

Pulling out of step is caused by either momentary loss and immediate restoration of power, commonly called a "voltage dip," or by a peak load exceeding the pull-out torque of the motor. In either case it is necessary, to prevent the motor from stalling, that excitation be removed so the motor can accelerate as an induction motor, and resynchronize, immediately on restoration of power, or

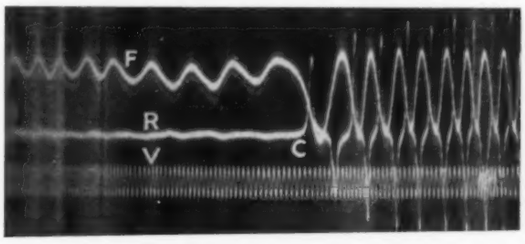


Fig. 13.—Oscillogram record of direct current excitation marked (F), FR-2, or reactor voltage (marked R) and A.C. voltage (marked V). At point C motor pulled out of synchronism and a voltage was induced across reactor, as shown. This voltage closes Frequency Relay FR-2.

after the peak load has passed. Unless field excitation is removed resynchronization cannot be accomplished, and the motor comes to a stop and must be restarted. It is apparent that in the interest of continuous operation alone, automatic resynchronization should be a part of all synchronous motor control.

Assuming a three-second voltage dip, a synchronous motor driving a centrifugal pump will drop to approximately 70% of full speed. When normal voltage is restored, the frequency relay that closed the field contractor will now open it, thus permitting the motor to again accelerate to full speed and synchronize. The reclosing action of FR-2 is illustrated by the oscillogram shown in Figure 13. R represents the voltage across the reactor X in Figure 12. There is practically no voltage R as long as the motor is running in synchronism as direct current is flowing through reactor X. The motor was caused to fall out of step at point C, Figure 13, by weakening the excitation, and as each rotor pole slipped by a stator pole, a high voltage was induced, which, it will be seen by referring to Figure 12, will close FR-2 and remove the excitation from the motor. (The pulsation in the D-C field current F (Figure 13) up to the point C is caused by the motor operating a heavy pulsating load. The field current after point C is caused by the voltage R.) It will be seen that FR-2 is instantly alert to remove field excitation in the event of subsynchronous speed.

Without the kick-off feature, the motor, when running below synchronous speed with excitation applied, will come to a stop, regardless of the amount of load, taking heavy inrushes of current from the line, which will trip the overload relays. If the synchronous motor has sufficient torque to pull the full load into synchronism or if the load can be relieved automatically, no interference to normal operation will be experienced from voltage dips or excessive momentary peak loads when the FR-2 relay control with kick-off feature is used.

Sheet and tin mill synchronous motor drives are subject to high irregular and intermittent peak loads due to the nature of the rolling operation. On these drives, by use of the kick-off feature of this Control System, it is not necessary to motor for the maximum peak load. Instead, by providing proper flywheel effect, the motor can be allowed to fall out of step momentarily and to resynchronize when the peak has passed. The kick-off principle permits automatic resynchronization without interruption to the continuous operation of the mill.

On certain crusher drives, synchronous motors with pull-out horsepower considerably below the peak loads have been applied. The kick-off feature permits these motors to resynchronize 100 to 200 times per day after momentary peak loads imposed by the crusher. Hence it is not necessary to motor large enough to handle all peaks without pulling out of step.

DELAYED LOW VOLTAGE RELEASE

Some power systems are subject to occasional dips caused by momentary loss of, and immediate restoration of, power. The cause of these dips may be insulator spill-over, line or cable short-circuits, switching disturbances, etc. Their duration is usually 5 cycles to approximately 90 cycles. The usual effect of these voltage dips is to cause the synchronous motors to fall out of step, in addition to opening of the line switches of the motors.

To maintain continuous operation through momentary power disturbances, provision is made in this Control System to prevent opening of the control switches to the motor. By maintaining the primary connections of the motor closed, the motor is in a position to automatically resynchronize as soon as power is restored, providing, of course, that the motor has sufficient pull-in torque for the drive, or means are used to unload automatically during the resynchronizing period.

In this Control System delayed low voltage release is provided in two ways, as follows:

1. Time delay, undervoltage release push-button station, or other suitable delayed undervoltage relay.
2. Direct current latching for control switches.

The time delay push button or other suitable de-

layed undervoltage relay is usually supplied for use with centrifugal pumps and fans, motor generator sets, or any drive on which the motor is designed to synchronize under full load. Whenever a voltage dip occurs which will permit the A-C. contactors, relays and latching magnets on the control to drop open (a dip to 50% or less normal voltage) the start button circuit, or the line switch is held closed for approximately one and one-half seconds, so that if the voltage returns to normal within that period, the control will function as during the initial starting of the apparatus.

Where an unloader is provided, for example on an air compressor, to unload the driven machine so as to permit the motor to resynchronize, direct current latching may be used to limit the operation of the unloader to only severe voltage dips. In direct current latching the A-C. line oil switch or contactor and field contactor are held closed by direct current, supplied from the source of excitation, to hold the control in the run position until the motor actually slips out of step or power goes off for more than a few seconds. As the switches do not open during the momentary period of disturbance, the motor will continue in synchronism through any dips except those sufficiently severe to pull the motor out of step.

To permit automatic resynchronizing for those drives for which it is not feasible to supply full-load pull-in torque in the motor, various types of automatic unloaders have been developed. These unloaders release the load on the driven machine, on an air compressor, for example, by holding open the suction valves. Unloaders are developed for a wide variety of synchronous motor applications, including gas and air compressors, and reciprocating pumps which are common in the steel industry; also for other drives not common in the steel industry, such as ammonia compressors, pulp grinders, etc.

In conclusion it will be seen that the Hibbard Control System is a complete system of control for synchronous motors which automatically starts the motor and driven machine under the best conditions, in the shortest time, every time and keeps it running through momentary power or load disturbances. In short, this control system eliminates all starting and operating difficulties which were formerly experienced with synchronous motors, and which held back their universal acceptance in industrial fields.

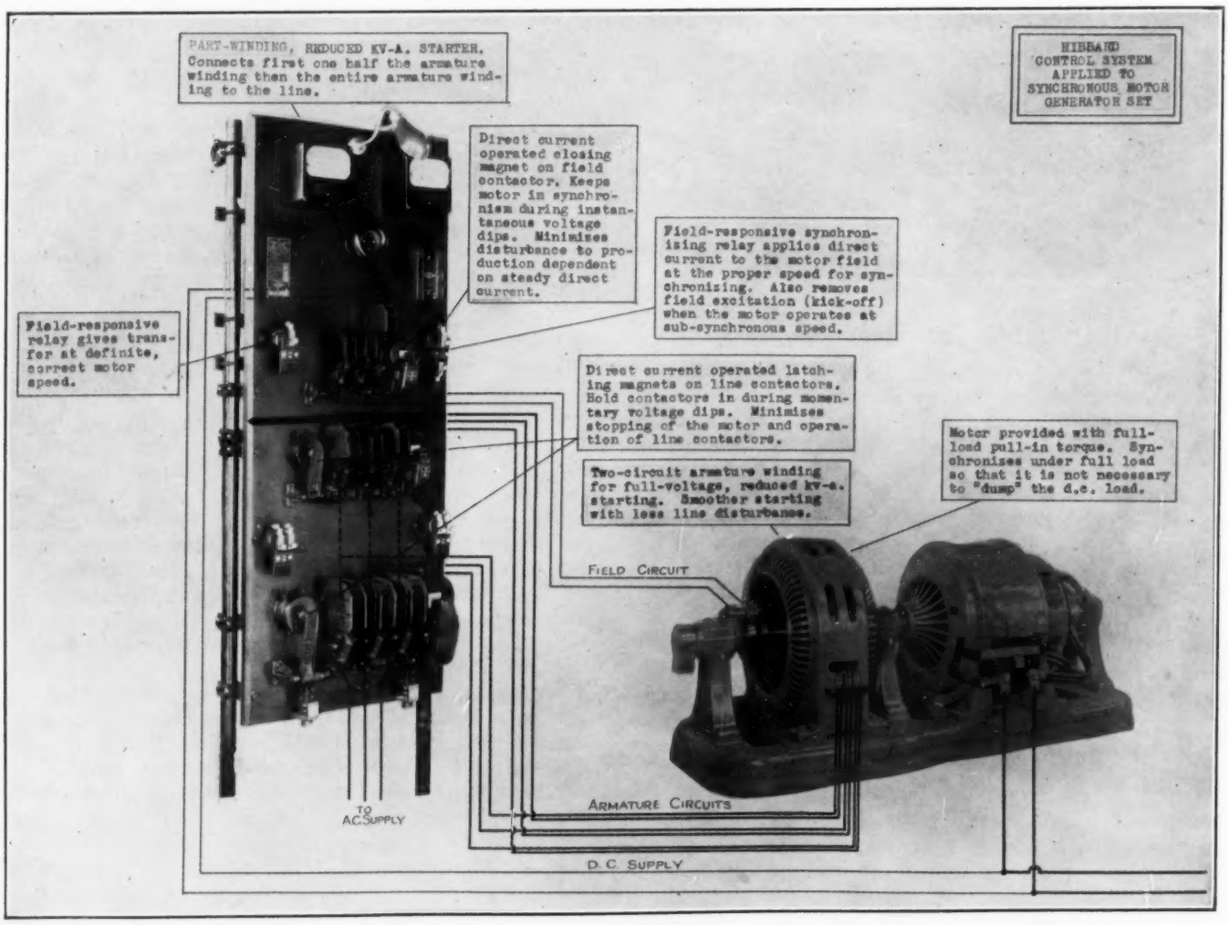

PART-WINDING, REDUCED KV-A. STARTER. Connects first one half the armature winding then the entire armature winding to the line.
HIBBARD CONTROL SYSTEM APPLIED TO SYNCHRONOUS MOTOR GENERATOR SET
Direct current operated closing magnet on field contactor. Keeps motor in synchronism during instantaneous voltage dips. Minimizes disturbance to production dependent on steady direct current.
Field-responsive synchronizing relay applies direct current to the motor field at the proper speed for synchronizing. Also removes field excitation (kick-off) when the motor operates at sub-synchronous speed.
Field-responsive relay gives transfer at definite, correct motor speed.
Direct current operated latching magnets on line contactors. Hold contactors in during momentary voltage dips. Minimizes stopping of the motor and operation of line contactors.
Two-circuit armature winding for full-voltage, reduced kv-a. starting. Smoother starting with less line disturbance.
Motor provided with full-load pull-in torque. Synchronizes under full load so that it is not necessary to "dump" the d.c. load.
FIELD CIRCUIT
TO A.C. SUPPLY
ARMATURE CIRCUITS
D.C. SUPPLY

Fig. 14.—Hibbard Control System applied to Synchronous Motor Generator Set. Part-winding reduced-KV-A. starting is used and the motor will synchronize under full load. Time delay undervoltage release and the kick-off feature permit automatic resynchronizing without "dumping" of D.C. load.

Discussion

"The Hibbard Control System and Its Application To Synchronous Motors In Steel Mills"†

By W. H. FELDMANN* and S. P. BORDEAU*

Discussed by

W. H. Feldmann, Electric Machinery Manufacturing Company, Minneapolis, Minn.

J. J. Booth, Electrical Superintendent, National Tube Company, Gary, Ind.

S. L. Henderson, Electrical Superintendent, American Steel & Wire Company, Cleveland, Ohio.

J. D. Donovan, Electrical and Mechanical Superintendent, Republic Steel Corporation, Massillon, Ohio.

O. C. Callow, Assistant Electrical Engineer, Freyn Engineering Company, Chicago, Ill.

S. N. Roberts, Electrical and Mechanical Superintendent, Atlantic Steel Company, Atlanta, Ga.

A. L. Reichert, Electrical Superintendent, Bourne-Fuller Plant, Republic Steel Corporation, Cleveland, Ohio.

F. W. Cramer, Chief Electrical Engineer, Republic Steel Corp., Youngstown, Ohio.

J. Farrington, Electrical Superintendent, Wheeling Steel Corporation, Steubenville, Ohio.

F. O. Schnure, Electrical Superintendent, Bethlehem Steel Company, Sparrows Point, Md.

R. W. Davis, Allis- Chalmers Manufacturing Company, Milwaukee, Wis.

W. H. Feldmann: (Chairman Booth explained that my talk had been presented to the Cleveland Section a short time previous and was being given at this General Convention because of inability of another program speaker to present his paper at that time.) I am very happy for that explanation, because I feel it is an injustice to appear twice before the members of the Cleveland Section and deliver a talk which I gave a few months ago in Cleveland. I hope the Cleveland Section will not be bored with what I am going to say.

J. J. Booth: Gentlemen, I am sure that you will all agree with me that Mr. Feldmann has given us a very interesting paper here this morning. In order that we may get the discussion of this particular paper over, we will proceed with that part of it right away. I am going to ask Mr. Henderson to start the discussion. Mr. Feldmann, will you please take notes and answer the questions at the end of the discussion?

S. L. Henderson: Mr. Chairman and Gentlemen: I have had the honor of listening to this paper before, and I am very much impressed with the strides that have been made in control which would keep the motor on the line, that is, a synchronous motor on the line.

Mr. Feldmann has brought out some very good points. I think quite a number of you will enter into the discussion, and I am quite sure that Mr. Feldmann will answer your questions.

J. D. Donovan: I enjoyed the paper very much. I think there is no question that synchronous motors are coming into their own and have many applications in steel plants. However, I would like to ask the author, to what capacity Synchronous motors have gone.

J. J. Booth: I note that Mr. Feldmann made the remark that they had the one and only synchronous reversing motor in the country. I think it's in the world; I don't know of any other.

Has anyone other than Mr. Feldmann seen this application? Personally, I have not seen it. I have promised myself a trip there two or three times, and I expect to make it within the next six months. Is there anyone here who has seen this application? Mr. Callow, have you seen it?

O. C. Callow: I came in late and didn't get to hear the paper. However, I would like to ask one question in connection with disintegrating motors. How do you bring the motor up to speed in a period of time, say, some sixty seconds?

S. N. Roberts: I don't think I can give you any information. All we have are the usual starters on the Line system I am afraid I don't know a thing about the Hibbard Control System with the exception of what I learned this morning. I do think the paper was very interesting and gives you food for thought. However, I can't add anything to it.

A. L. Reichert: I don't believe I have anything new to offer on this subject. We had this subject up with our local section about two months ago, and we did have quite a discussion at that time. I made the remark that I certainly was glad to hear about synchronous motors, and I believe we have some-

*Electric Machinery Mfg. Co., Minneapolis, Minn.

†Presented before 27th Annual A. I. & S. E. E. Convention, Cleveland, Ohio, June 17th, 1931.

thing here that we have all been looking for, for some time. Other than that I don't know that I can offer any discussion of this paper, except that I know it was very interesting to all of us.

F. W. Cramer: Mr. Chairman and Gentlemen: I really have no discussion. I would, however, like to ask Mr. Feldmann a question. We had a rather unusual experience about six months ago with one of his motors, which ran without any field on. What's puzzling me is I don't know how it ran that way. I was wondering whether you incorporated that in your control, and whether you have a protective device if that trips the A.C. off.

J. Farrington: I have no comments to make on synchronous motors, except that I am a firm believer in using them wherever possible, and we may use them on 1500 horsepower right across the line. We really believe if they can in most cases be used instead of induction motors they should be used. That is about all I can say.

F. O. Schnure: I was too late to hear Mr. Feldmann's paper; however, I have a great deal to say about synchronous motors. We have, since 1927, been running a 4000 and 6500 horspower motor on continuous mill work, and a couple of 6500 horsepower motors on motor generator sets. We have them running and starting.

Synchronous motors can be applied, and should be applied wherever possible, on steel mill work. We started some just a day or so before we left. I never saw a machine start easier than those machines. I think we ought to congratulate the manufacturers of synchronous motors and control on their ability to put these machines on the line as well as they have.

We have never noticed any flicker or anything like that on our 6500 horsepower motors. Of course, the system is rather large. However, I think the future of synchronous motors is going to be bright.

O. C. Callow: In connection with the job we are doing in England we specify synchronous motors for various interests. We found that manufacturers did not make synchronous motors as we thought they did, but they offered what they call a synchronous induction motor. I didn't know what that was. Apparently, this synchronous induction motor is a motor which is started on the circuit, and when it comes up to speed they excite the secondary winding which is done through the A.C. rings. They claim very good performance. I thought that might be of interest.

R. W. Davis: Yes, we have done a little work on synchronous motors. I might say that a synchronous motor can be applied in any place where you can use an induction motor. There has, however, been a limitation where you couldn't apply a synchronous motor where you needed slip, as on a fly-wheel set. However, I think the time is not very far off when we will be able to use synchronous motors for that purpose also.

W. H. Feldmann: This is in reply to Mr. Callow's question as to how to get the long delay starting period on disintegrating motors. First it might be well to mention the need for slow acceleration with consequent long starting periods. The rotor of a disintegrator is a very heavy mass and yet of such design that it is highly advisable to limit the mechanical strain that is imposed by fast acceleration. Now the speed of acceleration is determined by the torque of the motor that is in excess of the torque required to overcome the friction and windage loss in the disintegrator at any given speed. A number of such motors manufactured by our company were designed with the part-winding starting method and a starting torque curve that was only slightly in excess of the friction torque requirements of the disintegrator. Considerable data was obtained from the disintegrator manufacturer, including WR^2 etc., to calculate the exact torque required by the disintegrator at all points. Where part-winding starting is used for disintegrator a large part of the acceleration period is accomplished on part-winding, the full motor winding being connected near the synchronizing speed.

Answering Mr. Cramer's question, synchronous motors without excitation are poor induction motors at least from the power factor standpoint due to the large air gap inherent in synchronous motor designs. Consequently the current when carrying full load is two to three times normal resulting in many times normal stator heating. Further the squirrel cage winding being designed only for starting service heats very rapidly when carrying full load as an induction motor. It is a fact, however, modern welded, and brazed squirrel cage windings can become red hot without serious deterioration and consequently the limit of performance is the stator winding. The time element is determined largely by the radiating and thermal capacity of the machine. Slow speed machines can safely operate as long as 15 minutes without excitation carrying full load and higher speed machines from 5 to 7 minutes. In such an event effective overload protection should protect the motor although the no d.c. or the d.c. failure protection is an additional safeguard that can be easily applied at low cost.

Answering Mr. Donovan's question, the reversing mill referred to is a 600 HP, 300 RPM machine which is a good average size for copper breakdown rolling.

The Metallic Charge In Basic Open Hearth Operations—Some Factors Affecting Operating Economies

In a paper presented before the American Iron & Steel Institute Friday, October 23, 1931, Clarence D. King, Chairman, Open Hearth Committee, U. S. Steel Corporation, New York, N. Y., presented some very interesting facts and data in connection with Basic Open Hearth Operations.

This paper called attention to the intensive study in recent years of Open Hearth Operations, which has led to notable improvements in production rates, fuel consumption, furnace life and those costs for which the Open Hearth Operator is normally held responsible. As a rule the Open Hearth Operator is furnished raw materials in quality and prices over which he has no control, generally, in his opinion the ultimate cost of the net metallic mixture is fixed and his criterion of the performance of the open hearth is the cost above net metallic mixture.

However, if this standard alone is used to determine the efficiency of the open hearth, the losses involved in conversion are entirely disregarded and may result at times in increased ingot costs, in spite of decreased cost above net metal. While the term "Cost above Net Metal" is generally understood by the steel industry, for purposes of clarity it should be stated that in the discussions involved the cost above net metal embraces all costs incidental to the conversion of any metallic mixture into steel ingots, but excludes the cost of ferro-alloys and the monetary losses involved in the conversion of the charge into ingots. The latter losses would include metalloids eliminated; the metallics lost in slag, in slag pockets, checker chambers, waste gases, etc.; and finally includes losses of material incidental to handling, etc.

The monetary losses represent as much as 40% of the cost above net metal and constitute an important factor in the total ingot cost. Such losses will be represented by the production of scrap, as well as irrecoverable losses, and appreciably affect the ingot yield. Since the cost above net metal ordinarily constitutes only from 15% to 30% of the total ingot cost, it is obvious that any appreciable decrease in yield in turn affecting the cost of the gross and net metallic mixture may offset measurable savings in the cost above net metal.

With the many improvements made in open-hearth practice during the past decade, the cost above net metal has, as a rule, been materially reduced; and this decrease has made the item of "Loss and Additions" of relatively greater importance. While in a large measure the cost above net metal does represent the progress made by an open hearth plant, the true criterion of its performance may be more accurately indicated by the conversion cost, namely, the difference between total cost of ingots and the cost per ton of metallic charge (alloys excluded).

This paper is devoted to a treatment of the general principles underlying the conversion of metallic charges into basic open-hearth ingots and covers some important factors influencing operating economies. These will include the effect of changes in yields, scrap production, and the possible conversion of some losses into scrap recovery. The influence of types of scrap used and changes in ratios of pig iron and steel scrap is also discussed. Since the influence of changes in type and analysis of pig iron on operating economies has been previously thoroughly covered in a paper by C. L. Kinney, Jr.,[1] no discussion of this phase of the metallic charge will be included, nor will any attempt be made to correlate the following to the quality of steel produced, since in any discussions of the metallic charge it is assumed that the slags produced, or the additions used, will be of the character or amount desired to produce the required quality of steel.

Since a variety of conditions, types of steels made, physical limitations, scrap and pig relations will vary from plant to plant, the illustrations furnished in the discussion can be considered only as general principles applying to a definite set of conditions, which must accordingly be revised to suit the conditions existing at individual plants.

The following tables were taken from Mr. King's paper and are being presented to the readers of the IRON & STEEL ENGINEER with the thought that they will be of value to all Open Hearth Operators.

1 C. L. Kinney, Jr.: "Economic Significance of Metalloids in Basic Pig Iron in Basic Open Hearth Practice." Transactions American Institute of Mining and Metallurgical Engineers, 1924, p. 136.

EFFECT OF REDUCTION IN IRON SCRAP AND IRON SKULLS ON TOTAL INGOT COST AT HYPOTHETICAL BASE AND PRICES, ASSUMING DECREASE FROM 1.20% TO .50% IRON SCRAP AND SKULLS PER TON HOT METAL

Material	Standard		Price per gross ton materials	With reduced iron scrap and skulls	
	Gross tons	Total cost		Gross tons	Total cost
Hot metal	52.083	$ 937.49	$ 18.00	52.083	$ 937.49
Pig iron, molds, etc.	18.153	326.75	18.00	18.153	326.75
Steel scrap	37.845	643.37	17.00	37.845	643.37
Iron in ore, etc.	5.114	51.14	10.00	5.114	51.14
Pure manganese	.409	40.90	100.00	.409	40.90
Pure silicon	.046	6.90	150.00	.046	6.90
Gross metal	113.650	$2006.55		113.650	$2006.55
Iron scrap and iron skulls	.625	$9.06	14.50	.260	$3.77
Pit scrap and steel skulls	3.682	47.87	13.00	3.682	47.87
Ingot butts and condemned ingots	1.148	21.81	19.00	1.148	21.81
Total scrap produced	5.455	$78.74		5.090	$73.45
Net metal		$1927.81			$1933.10
Cost above net metal		500.00			500.82
				Total	$2433.92
Reduction in cost of handling, preparing, etc., iron scrap and iron skulls at $2.00 per ton iron or iron skulls					.73
Grand total ingot cost		$2427.81		Grand Total	$2433.19
Tons ingots produced	100.			100.328	
Cost per ton ingots		$24.278			$24.252
Savings per ton ingots					.026

EFFECT OF REDUCTION IN PIT SCRAP AND STEEL SKULLS ON TOTAL INGOT COST, HYPOTHETICAL BASE AND PRICES, ASSUMING DECREASE FROM 3.24% TO 2.25% PIT SCRAP AND SKULLS PER TON OF CHARGE

Material	Standard		Price per gross ton materials	With reduced Pit scrap and skulls	
	Gross tons	Total cost		Gross tons	Total cost
Hot metal	52.083	$ 937.49	$ 18.00	52.083	$ 937.49
Pig iron, molds, etc.	18.153	326.75	18.00	18.153	326.75
Steel scrap	37.845	643.37	17.00	37.845	643.37
Iron in ore, scale, etc.	5.114	51.14	10.00	5.114	51.14
Pure manganese (from 80% ferro-manganese)	.409	40.90	100.00	.411	41.10
Pure silicon (from 50% ferro-silicon)	.046	6.90	150.00	.046	6.92
Gross metal	113.650	$2006.55		113.652	$2006.77
Iron scrap and iron skulls	.625	$9.06	14.50	.625	$9.06
Pit scrap and steel skulls	3.682	47.87	13.00	2.557	33.24
Ingot butts and condemned ingots	1.148	21.81	19.00	1.148	21.81
Total scrap produced	5.455	78.74		4.330	64.11
Net metal		$1927.81			$1942.66
Cost above net metal		500.00			501.41
					$2444.07
Reduction in cost of transportation, preparation, stocking, etc., at $2.00 per ton pit scrap					2.25
Grand total ingot cost		$2427.81			$2441.82
Gross tons ingots produced	100.00			101.125	
Cost per gross ton ingots		24.278			24.146
Savings per gross ton ingots					.132

HYPOTHETICAL COMPARISON SHOWING EFFECT OF INCREASED OPEN HEARTH SLAG AT BLAST FURNACES AND EFFECT ON OPEN HEARTH OPERATIONS

Material	Period 2 Gross tons	Period 2 Total cost	Price per gross ton materials	Period 3 Gross tons	Period 3 Total cost
Hot metal	55.944	$1006.99	$ 18.00	55.944	$1006.99
Iron scrap, molds, etc.	3.370	60.66	18.00	3.370	60.66
Steel scrap	47.989	815.81	17.00	47.989	815.81
Iron in ore, scale, etc.	4.494	44.94	10.00	4.494	44.94
Additions (pure)	.562	67.44	120.00	.562	67.44
Gross metal	112.359	$1995.84		112.359	$1995.84
Miscellaneous scrap	3.370	$43.81	13.00	3.370	$43.81
Ingot butts and condemned ingots	1.124	21.36	19.00	1.124	21.36
Metallics in O. H. slag	2.450	24.50	10.00	3.750	37.50
Total scrap produced	6.944	$89.67		8.244	102.67
Net metal		$1906.17			$1893.17
Cost above net metal		500.00			500.66
Grand total cost		$2406.17			$2393.83
Tons ingots produced	100.00			98.75	
Cost per ton ingots		$24.062			24.241
Additional cost					.179
Required savings at blast furnaces per ton pig iron due to increased use of open hearth slag to give equal cost ingots					.316
Required price for pig iron Period 3 to equal ingot cost of Period 2					17.684

EFFECT OF VARYING YIELDS ON OPERATING COSTS—BASIC OPEN HEARTH—BASED ON EQUAL CONDITIONS AND HYPOTHETICAL PRICES FOR MATERIALS

Percentage iron charged per ton of charge	40.4		46.6		53.1		57.5	
	Per cent. materials per ton ingots	Cost per ton ingots	Per cent. materials per ton ingots	Cost per ton ingots	Per cent. materials per ton ingots	Cost per ton ingots	Per cent. materials per ton ingots	Cost per ton ingots
Hot metal and pig iron, etc.	45.58	$ 8.204	51.76	$ 9.317	59.69	$10.744	65.13	$11.723
Steel scrap	62.54	10.632	55.09	9.365	45.97	7.815	39.54	6.722
Iron in ore, scale, etc.	1.10	.110	3.33	.330	5.85	.585	7.70	.770
Gross metal (additions excluded)		$18.946		$19.012		$19.144		$19.215
Scrap Produced:								
Iron scrap and iron skulls	.220	.032	.255	.037	.303	.044	.328	.048
Pit scrap and steel skulls	3.028	.394	3.054	.397	3.091	.402	3.115	.405
Ingot butts and condemned ingots	1.101	.209	1.106	.210	1.124	.214	1.133	.216
Metallics in slag consumed at blast furnaces	1.299	.130	1.677	.168	2.125	.213	2.413	.241
Total scrap		$ .765		$ .812		$ .873		$ .910
Net metal (additions excluded)		$18.181		$18.200		$18.271		$18.305
Difference in net metal cost per ton ingots compared to 40.4% pig charge				$ .019		$ .090		$ .124
Price per ton of iron, steel scrap and ore		$17.346		$17.255		$17.167		$17.099
Loss		.835		.945		1.104		1.206
Assuming $5.50 cost above plus additions for 57.5% pig charge—required costs to obtain equal cost ingots		5.624		5.605		5.534		5.500
Total ingot cost on above assumptions								
With $17.00 steel scrap		$23.805		$23.805		$23.805		$23.805
With 16.00 steel scrap		23.179		23.254		23.345		23.409
With 15.00 steel scrap		22.554		22.704		22.885		23.014
With 14.00 steel scrap		21.929		22.153		22.425		22.619

COMPARATIVE DATA FOR OPEN-HEARTH FURNACES CHARGED WITH DIFFERENT TYPES STEEL SCRAP

	Heats charged with crop scrap	Heats charged with bundled sheet scrap	Heats charged with compressed sheet scrap
Time of heats—charge to tap	8 hrs. 16 min.	8 hrs. 25 min.	7 hrs. 43 min.
Bottom repairs, bottom making, etc.	40 min.	1 hr. 8 min.	55 min.
Gross time per heat, including difference in bottom delays, etc.	8 hrs. 16 min.	8 hrs. 53 min.	7 hrs. 58 min.
Gross tons ingots and scrap produced per heat	74.12	68.04	69.79
Tons per hour on gross time of heat	8.97	7.65	8.76
Per cent decreased hourly output	.....	14.7	2.4
Materials charged:			
Total iron, pounds	85505	87250	86820
Steel scrap, pounds	85320	85280	85360
Iron in ore, scale, etc., pounds	7560	3970	880
Manganese (pure), pounds	585	632	656
Silicon (pure), pounds	60	40	75
Limestone, pounds	17350	16740	16860
Dolomite, pounds	5200	5200	5200
Gallons fuel oil per ton ingots	30.6	36.7	31.6
Time loading (per heat) cranes	31 min.	1 hr. 14 min.	1 hr. 3 min.
Time loading (per heat) stockers	1 hr. 9 min.	3 hrs. 24 min.	1 hr. 49 min.
Time charging (per heat)	16 min.	57 min.	1 hr. 4 min.
Ingot yield and scrap produced	92.74%	86.05%	89.94%
Loss	7.26%	13.95%	10.06%

COMPARISON OF VARIOUS TYPES STEEL SCRAP CHARGED AND EFFECT ON OPERATING ECONOMIES

Materials, charged, etc.	CROP SCRAP Tons materials charged	CROP SCRAP Total cost	CROP SCRAP Cost per ton ingots	BUNDLED SHEET SCRAP Tons materials charged	BUNDLED SHEET SCRAP Total cost	BUNDLED SHEET SCRAP Cost per ton ingots	COMPRESSED SHEET SCRAP Tons materials charged	COMPRESSED SHEET SCRAP Total cost	COMPRESSED SHEET SCRAP Cost per ton ingots
Total iron	38.17	$ 687.06		38.95	$ 701.11		38.76	$ 697.68	
Steel scrap	38.09	647.53		38.07	647.19		38.11	647.87	
Iron in ore, scale, etc.	3.375	33.75		1.772	17.77		.393	3.93	
Manganese, pure (from 80% Ferro-Mang.)	.262	26.20		.282	28.20		.293	29.30	
Silicon, pure (from 50% Ferro-Silicon)	.027	4.05		.018	2.70		.033	4.95	
Gross and net metal		$1398.59	$18.869		$1396.97	$20.532		$1383.73	$19.825
Fuel oil used	2268 gal.	$ 90.72	$ 1.224	2497 gal.	$ 99.88	$ 1.467	2205 gal.	$ 88.20	$ 1.264
Limestone (tons)	7.746	15.49	.209	7.473	14.96	.220	7.527	15.05	.216
Calcined Dolomite (tons)	2.321	13.93	.188	2.321	13.93	.205	2.321	13.93	.200
Additional refractories expense	.....	.....	.....		2.04	.030		1.05	.015
Increased cost of stocking and charging	.....	.....	.....		5.00	.073		2.50	.036
Remainder items cost above with effect of decreased tonnage included	.....	250.46	3.379		239.23	3.516		237.49	3.403
Total cost above net metal	.....	$ 370.60	$ 5.000		$ 375.04	$ 5.511		$ 358.22	$ 5.134
Grand total ingot cost		$1769.19	$23.869		$1772.01	$26.043		$1741.95	$24.959
Gross tons ingots and scrap produced		74.12			68.04			69.79	

	Total ingot cost	Additional cost per ton ingots	Allowable price for scrap to give equal cost ingots
Crop scrap	$23.869	.....	$17.00
Bundled sheet scrap	26.043	$2.174	13.11
Compressed sheet scrap	24.959	1.090	15.00

COMPARISON OF RESULTS OBTAINED WITH COLD CHARGES AND VARYING AMOUNTS AND TYPES OF CHARGES

	Period No. 1	Period No. 2	Period No. 3	Period No. 4
Tons produced per sq. ft. per 1000 hours	17.29	19.00	17.90	18.90
Number of boxes charged per heat	100	125	115	121
Lbs. burnt lime per ton ingots	114	101	107	122
Lbs. fluorspar per ton ingots	12	13	12	10
Fuel per ton ingots (M.B.T.U's.)	5.760	5.720	5.400	4.900
Production—per cent ingots and scrap	95.3	94.8	93.6	93.6
Per cent loss	4.7	5.2	6.4	6.4
Per cent materials per ton charge:				
Pig iron	27.7	19.4	28.7	23.5
Cast iron	10.9	6.4	4.6	9.0
Steel scrap	60.2	74.0	65.6	66.8
Iron in ore, scale, etc	.9	.8	.6	.4
Pure manganese and silicon	.3	.4	.5	.3
Ratio of costs and prices:				
Cost net metal	100.0	91.8	93.6	71.2
Cost above net metal	100.0	98.5	89.4	90.6
Total ingot cost	100.0	93.7	92.4	76.8
Per cent reduction in total ingot cost contributed:				
By net metallic cost		93.2	60.0	89.1
By cost above net metal		6.8	40.0	11.9
Pig iron price per ton	100.0	94.3	88.7	81.5
Cast iron price per ton	100.0	96.0	94.0	65.4
Steel scrap price per ton	100.0	93.8	91.2	64.6

PRACTICE DATA AND COMPARISON OF EFFECT OF VARYING CHARGES IN DUPLEX OPERATIONS ON FINAL INGOT COST—HYPOTHETICAL BASIS AND PRICES

Details	%	%	%	%	%	%	%
Blown metal	60	65	70	75	80	85	100
Open-hearth (only) yield	92.95	93.10	93.25	93.40	93.55	93.70	94.15
Total scrap	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Total loss	4.05	3.90	3.75	3.60	3.45	3.30	2.85
Duplex yield	87.25	86.92	86.60	86.27	85.95	85.62	84.68
Fe in slag, shot, etc. (bessemer)	.66	.72	.77	.82	.88	.93	1.10
Miscellaneous scrap (bessemer)	.66	.72	.77	.82	.88	.93	1.10
Open-hearth miscellaneous scrap	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Open-hearth condemned ingots and butts	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total scrap	4.32	4.44	4.54	4.64	4.76	4.86	5.20
Total loss	8.43	8.64	8.86	9.09	9.29	9.52	10.12
Cost per ton ingots:							
Gross metallic mixture	$21.216	$21.335	$21.463	$21.590	$21.726	$21.833	$22.100
Scrap produced	.643	.658	.670	.681	.695	.708	.749
Net metallic mixture	$20.573	$20.667	$20.793	$20.909	$21.031	$21.125	$21.351
Permissible cost above net metal to give equal cost ingots assuming $4.00 cost above net metal with 100% blown metal operation	4.778	4.684	4.558	4.442	4.320	4.226	4.000
Total ingot cost	$25.351	$25.351	$25.351	$25.351	$25.351	$25.351	$25.351
Tons per month per furnace tapping 125-ton heats	14,000	15,200	16,667	18,000	19,000	20,000	25,000

Dynamic Properties of Arc Welded Joints*

By C. H. JENNINGS†

Recent developments in the art of electric arc welding have made it a universal tool for designers in nearly all lines of engineering work. Structures and machines that would have been riveted or cast several years ago are now being welded and are meeting with gratifying success.

It is needless to say that the increased application of arc welding has been primarily dependent upon the fundamental research that has been conducted upon the physical properties of welded joints. For many years weld research of this type was confined almost entirely to static tests and weld applications were limited to statically loaded structures. Recently, however, investigations on the dynamic properties of arc welds have been undertaken. The company with which the writer is connected has been

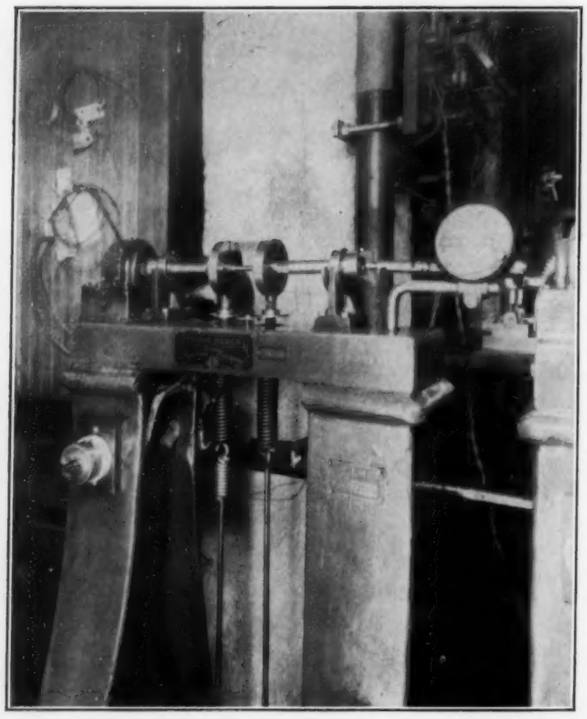


Fig. 1—Beam Type Fatigue Machine

very active along this line and the information that has been obtained is now being successfully applied in the design of their welded products.

Although both impact and fatigue properties of welds must be considered when designing for dynamic applications, only the fatigue properties will be discussed in this paper.

Fatigue Investigations On Butt Welds

The first investigations that were made by the author's company on the fatigue of welds[1, 2] were conducted on butt welds by means of rotating beam specimens of the Farmer type which were .3" in diameter at the critical section. The choice of this type of weld and specimen was influenced by the adaptibility of butt welds for such tests and the nature of the existing testing equipment. Figure 1 shows a machine for testing the small beam fatigue specimens.

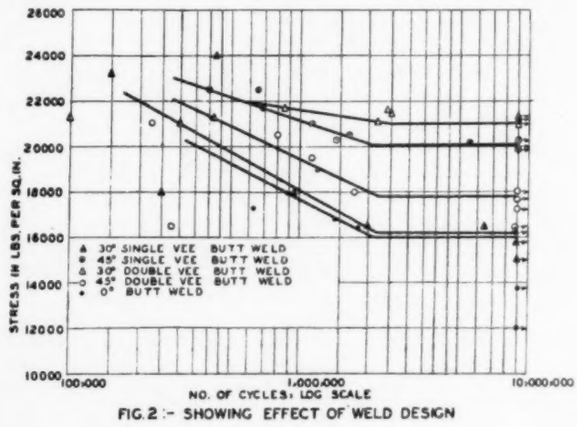


FIG. 2 :- SHOWING EFFECT OF WELD DESIGN

Fig. 2.

The butt welds tested by means of the small beam specimens were prepared from hot-rolled, low-carbon steel plates by using bare low-carbon steel electrodes and 150 amperes current. The information obtained revealed the fact that the type of joint had an important effect upon the endurance limit, and that the test data were subject to a great deal of scatter, thus making it difficult to accurately determine endurance limits in some cases.

The experimental curves which were obtained

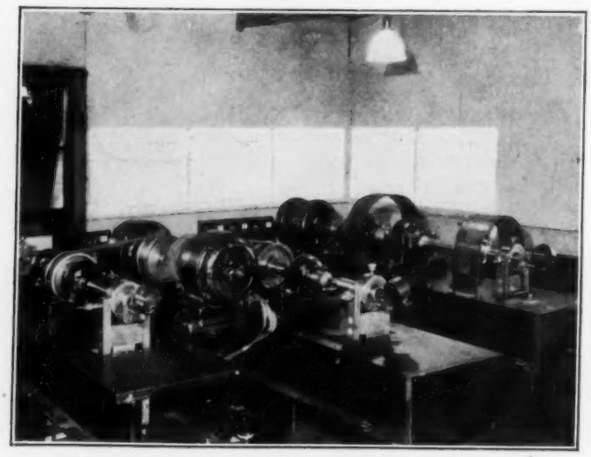


Fig. 3—Large Size Fatigue Testing Equipment

*Presented before A. I. & S. E. E. Electric Heating and Welding Conference, January 21, 1931.

†Research Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

1. Strength of Butt Welds by G. Lobo, Jr., Journal of American Welding Society, April, 1929.
2. Fatigue and Impact Tests for Welds by C. H. Jennings, Journal of American Welding Society, September, 1930.

from these tests are shown by Figure 2 and it will be noted that the endurance limits range from 16,000 lb./sq. in. for a parallel side butt joint to 21,000 lb./sq. in. for a 30° single vee joint. The important point in connection with this investigation was the relatively low endurance limits obtained as compared with the endurance limit of the parent metal which was about 27,000 lb./sq. in.

Subsequent to the investigation on small beam specimens, tests were made on cantilever specimens which were .468" in diameter at the critical section and on special large size specimens which were 2¼" in diameter at the critical section[3]. A photograph of a 2¼" test specimen mounted for tests is shown at the right of Figure 3.

Experimental curves obtained from 45° double vee welds made on hot-rolled, low-carbon steel with bare low-carbon electrodes using about 150 amperes current are shown in Figure 4. It will be noted that the endurance limits obtained from the larger specimens were lower than those obtained from the small beam specimens.

The low endurance limits as obtained from the large size specimens were probably due to the higher residual stresses which were present in the larger welds.

The fact that large welds have higher residual stresses than small welds and consequently a lower endurance limit, must be borne in mind when such welds are used in machines subject to dynamic loads. The weld size is not as important where purely static loads are concerned. The author has made tensile tests on 2¼", 45° double vee butt welds which were made with bare, low-carbon steel electrodes and the ultimate strengths obtained were well in excess of 55,000 lb./sq. in. This corresponds favorably with the results obtained on welds of smaller sizes.

Fatigue Investigations On Fillet Welds

In conjunction with the fatigue tests of butt welds, investigations on the fatigue of fillet welds were also conducted. All tests on fillet welds were made by means of double ended rotating cantilever specimens of the type shown in Figure 5b. The specimens were prepared from 2" diameter blanks of hot-rolled, low-carbon steel as shown by Figure 5a.

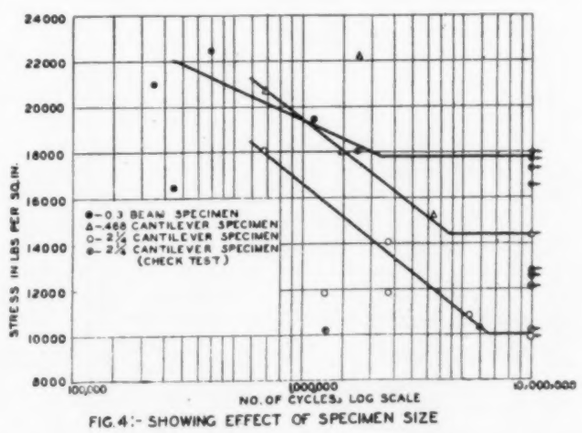


FIG. 4:- SHOWING EFFECT OF SPECIMEN SIZE

Fig. 4.

3. See Fatigue Tests of Large Specimens by R. E. Peterson. Trans. A. S. T. M., Vol. 29, Part II, p. 371 (1929).

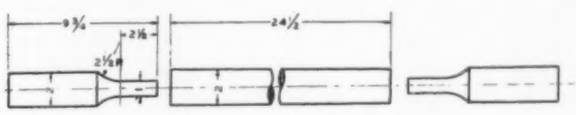
All welds were made with bare, low-carbon steel electrodes using 150 amperes current.

Tests were made on unmachined welds of various sizes, unmachined welds in which the welded parts were separated about 1/32", welds which were machined with a sharp corner at the base of the fillet, and welds which were machined with radii of ⅛, ¼, and ⅜" at the base of the fillet. Typical sketches of the different fillet welds are shown in Figure 6.

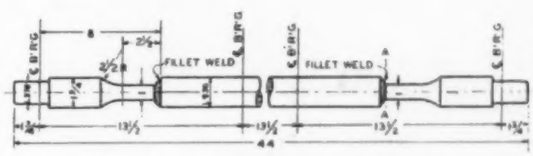
The results of these tests were expressed in terms of the stress in the welded bar at the base of the fillet (section A-A, Figure 6a) and were determined by means of the ordinary flexure formula, all stress concentration being neglected. The results in this form do not give the actual value of the stress in the welds but they put the different types of welds on a comparative basis as far as moment carrying capacity is concerned.

The results of this investigation are briefly summarized as follows:[4]

1. For given dimensions of welded parts there is a critical size fillet for which failure occurs through the weld and the parent metal at the base of the weld simultaneously. For the particular dimensions used in the test specimens the critical size fillet was .3" (t dimension in Figure 6a).
2. Welds large enough to cause failure to occur in the parent metal at the base of the fillet (section A-A, Figure 6a) developed an endurance limit corresponding to a stress of 18,500 lb./sq. in. in the parent metal. Weld sizes greatly in excess of the size necessary to produce failure in the parent metal (see Figure 6b) developed a slightly lower endurance limit. Tests made on .85" fillet welds developed an endurance limit corresponding to 17,000 lb./sq. in. in the parent metal.
3. Welds small enough to cause failure to occur through the weld (section B-B, Figure 6a) have endurance limits dependent upon the size of the weld. The smaller the weld, the lower the endurance limit. Tests made on .3" fillet welds (.3 is the t dimension on Figure 6a) produced an endurance limit corresponding to a stress of 18,200 lb./sq. in. in the parent metal.



a FILLET WELD SPECIMEN BLANKS



b FILLET WELD TEST SPECIMEN
FIG. 5

Fig. 5.

4. See Fatigue Tests of Fillet Welds by R. E. Peterson and C. H. Jennings. Presented before 1930 Annual Meeting of the A. S. T. M. at Atlantic City.

4. Unmachined fillet welds which had a small clearance between the welded parts (see Figure 6c) developed endurance limits lower than those obtained from unmachined welds with the welded parts butted together. Tests on .25″ and .33″ fillet welds with a clearance of 1/32″ between the welded parts developed endurance limits corresponding respectively to stresses of 11,700 lb./sq. in. and 12,000 lb./sq. in. in the parent metal.

5. Fillet welds machined to an angle of 45° with a sharp corner at the base (Figure 6d), which were of such a size as to produce failure in the parent metal, developed endurance limits much lower than those obtained for unmachined welds. Tests on .3″ fillet welds of this type developed an endurance limit corresponding to a stress of 14,700 lb./sq. in. in the parent metal.

6. Fillet welds which had a small radius machined at the base and sufficient backing to cause failure to occur in the parent metal (see Figure 6e) developed endurance limits slightly higher than those obtained from unmachined fillet welds.

a. Welds with a ⅛″ machined radius and ¼″ backing developed an endurance limit corresponding to a stress of 18,800 lb./sq. in. in the parent metal.

b. Welds with a ¼″ machined radius and ¼″ backing developed an endurance limit corresponding to a stress of 19,500 lb./sq. in. in the parent metal.

c. Welds with a ⅜″ machined radius and ¼″ backing developed an endurance limit corresponding to a stress of 19,700 lb./sq. in. in the parent metal.

Experimental curves of some of the tests are given in Figure 7.

The proper fillet weld design should be such as to cause failure to occur in the parent metal. Welds greatly in excess of the size required to produce failure in the parent metal are not desirable because of their excessive cost and the slightly lower endurance limit which they develop.

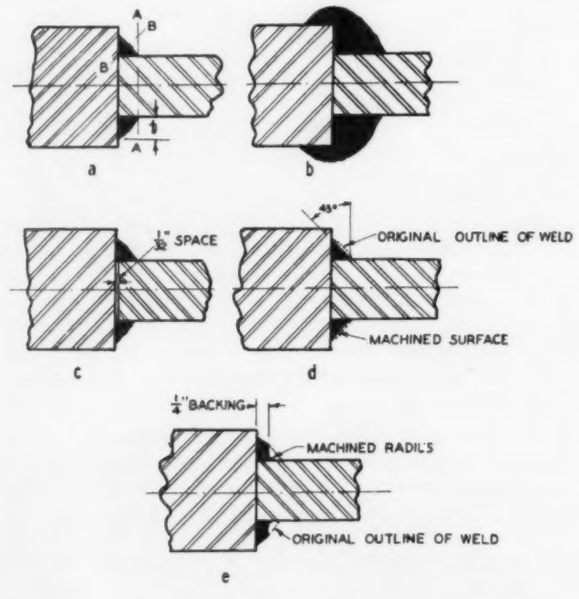


FIG. 6 – FILLET WELD TYPES

Fig. 6.

The welded parts of joints that are subject to dynamic stresses should fit together as tightly as possible in order to obtain the maximum efficiency and strength of the joint. The effect of a clearance between the welded parts was clearly shown by the above investigation.

Machining fillet welds to a sharp corner at the base has a very harmful effect upon the endurance limit of the joint. If machining a fillet weld is necessary, a small radius should be made at the base of the fillet.

Conclusion

The results of the various tests enumerated in this paper bring out the fact that the fatigue strength of both butt and fillet welds made on low-carbon steel with bare, low-carbon electrodes are low as compared to the fatigue strength of the metals joined, and that the fatigue strengths vary for different types of joints and welds. Because of this variation, the welding designer must be very careful in his choice of joints and working stresses.

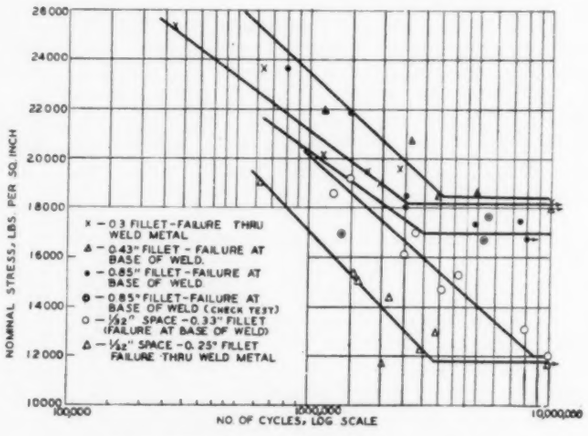

NOMINAL STRESS, LBS. PER SQ. INCH
28000
24000
22000
20000
18000
16000
14000
12000
10000
100,000
1,000,000
10,000,000
NO. OF CYCLES, LOG SCALE
x – 0.3 FILLET – FAILURE THRU WELD METAL
Δ – 0.43" FILLET – FAILURE AT BASE OF WELD.
• – 0.85" FILLET – FAILURE AT BASE OF WELD
⊕ – 0.85" FILLET – FAILURE AT BASE OF WELD (CHECK TEST)
○ – 1/32" SPACE – 0.33" FILLET (FAILURE AT BASE OF WELD)
Δ – 1/32" SPACE – 0.25" FILLET FAILURE THRU WELD METAL

FIG. 7 – FILLET WELD ENDURANCE CURVES

Fig. 7.

The fact that the endurance limit of weld metal is low does not infer that its use is not satisfactory for machines and structures which are subject to dynamic conditions. If a welded joint is properly designed, it will prove satisfactory for nearly any kind of service. Recent work by the author has shown that by changing the design of a composite welded joint, the endurance limit was raised from 10,000 lb./sq. in. to the endurance limit of the parent metals (27,000 lb./sq. in.)

Additional proof that welding is highly satisfactory for resisting dynamic loads is furnished by the large number of machines and machine parts[5] that have been weld fabricated by our Company and are operating with complete satisfaction.

5. Electrically Welded Structures under Dynamic Stress by M. Stone and J. G. Ritter. Jour. A. I. E. E., March, 1930, p. 202.

The Application of Health Lamps To The Iron and Steel Industry With Relation To Health and Efficiency†

By M. J. DORCAS*

For a hundred years electricity has been contributing to the welfare of the human race. The use of electricity for power and light is now universal. Other uses of smaller quantities are equally important for our modern existence. Among these is the use of electricity in the theory and practice of medicine, x-rays, diathermy, electro-cardiographs, ultraviolet generators, and electrochemical methods have contributed much to the study of medicine, the preparation of pharmaceutical products, and the diagnosis and treatment of disease.

More recently, say within the last twenty years, electricity has become important in the application of some of the ideas developed by those interested in preventive medicine. Temperature, ventilation, and light are simple but important factors of the environment in which we live and work, and which affect our health and ability to work or our efficiency.

"Health Lamps" have now been developed to an extent that they can supply any required amount of any kind of light. They are used to replace or supplement natural light. By their use the conditions of the environment about us can be controlled so far as light is concerned.

These lamps are usually arcs. They can be open or enclosed carbon or metal vapor arcs, and sometimes are supplemented by radiation from highly heated filaments. The light from these lamps looks much like that from any other ordinary light source. These health lamps, however, differ from the others in that they emit the invisible ultraviolet rays found in sunshine in addition to the visible light that we can see.

The past twenty or thirty years have also seen a tremendous development of legislation and customs relating to the responsibilities of an employer for the health of those whom he employes. Many modern industrial processes and operations are so complicated that they require those who operate the machines or direct the processes to be highly efficient. Any temporary or permanent impairment of health reduces this efficiency. It is difficult to define health and disease. They are relative terms, yet it is certain that a sick man can do less work, and is less efficient than a man in perfect health. We, therefore, assume that anything that tends to resist disease and therefore tends to maintain or improve health also improves the efficiency of the individual. The requirements for efficient personnel and the complicated legal obligations under which modern industry must operate result in a situation where anything that will promote or maintain the health of industrial personnel in general will save money or make money for the industry.

Artificial sunshine lamps promise to do this especially for the iron and steel industry since steel plants and surrounding territories are especially apt to be under a cloudy, smoky, or dusty atmosphere which prevents normal sunshine from reaching them.

Ordinary lighting equipment is entirely satisfactory for the purpose of providing artificial light with

*National Carbon Company, Cleveland, Ohio.

†Presented before Twenty-seventh Annual A. I. & S. E. E. Convention, Cleveland, Ohio, June 15, 1931.

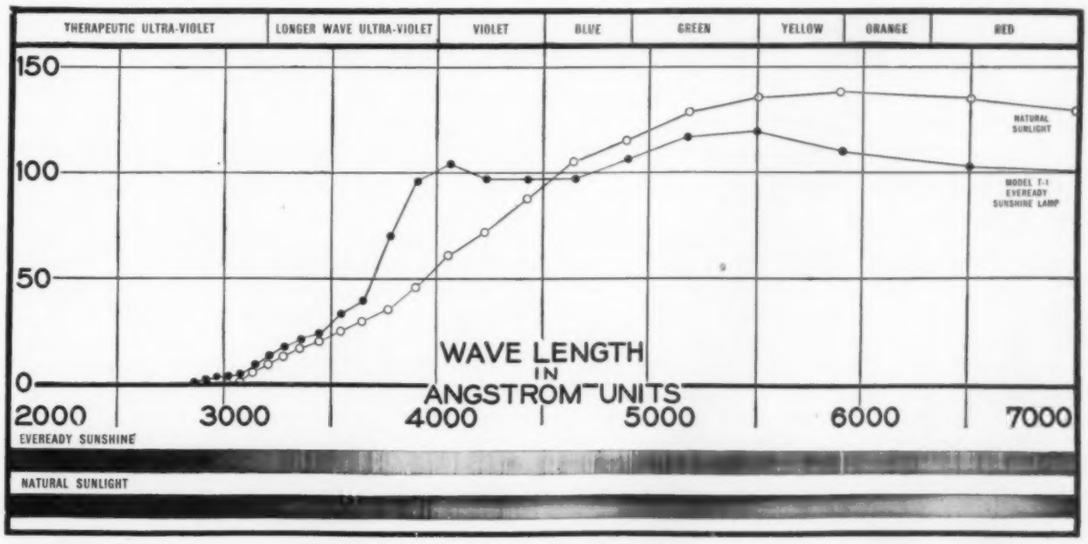


FIG. 1.

which to see. In spite of the existence of these satisfactory lamps, people continue to seek the sunshine. The popularity of the sunshine is explained partially by the feeling of well-being that is experienced during and after exposure to direct natural sunshine such as is found in the country districts and especially in the mountains and at the seashore. Some people feel relaxed; some seem exhilarated; nearly everyone improves in mental attitude and alertness. There exists a firm belief in the minds of people in general that exposure to sunshine is beneficial to health. Such a wide-spread belief, which in this case is almost a natural instinct compelling us to seek the sunshine, is an indication that the human body needs a certain amount of sunshine which our modern life, under smoke screens and inside of buildings and clothing, does not permit us to receive.

Sunbaths, as these exposures to natural sunshine are sometimes called, involve also exposures to fresh air and some rest or relaxation. The exposure of the skin surface to the light alone, however, is responsible for much of the effect obtained since rest and artificially produced weather without the light does not produce as desirable results.

Examination of sunshine shows that it contains ultraviolet energy in addition to the visible light and contains the visible colors in rather different proportions than are found in most artificial light sources. It also contains some heat rays. Sunshine can be measured and analyzed. It is found that it can be described in a way by a curve known as a spectral energy distribution curve such as shown in Figure I. The curve with open circle points represents the spectral energy distribution of natural sunlight. This curve expresses the quality of radiation or wave lengths as abscissae and the quantity of each kind as ordinates.

Artificial sources can closely duplicate this as shown by the second curve of Fig. 1, or can supply chiefly the ultraviolet portion as shown.

Smoke and dust are responsible for the loss of much of the benefit of the sunshine.

Experiments have shown that downtown Chicago and Baltimore receive only one-third to one-half the ultraviolet from the sunshine due to the dirt and smoke over the city, and that only one-half of that reaching the tops of the buildings reaches the street level. If these comparatively clear business sections receive so little of this desirable sunshine, steel works and their immediate surroundings must receive much less.

An official investigation in Chicago by the Department of Health links the death rate and number of pneumonia cases with the amount of ultraviolet, and recommends exposure to sunshine lamps to make up for this deficiency and to improve the health of the city as a whole.

This ultraviolet is the part of the sun's rays which is missing in the light that reaches us under clouds of smoke and dust. Window glass does not transmit it; neither do the ordinary materials of clothes. This ultraviolet is not supplied by heaters, nor by our ventilating or illuminating systems. It is the only one of the environmental factors of fresh air, proper temperature, and light that is not now generally found. Modern construction provides good air, good illumination, and proper or modified temperatures, but the modern industrial worker has not in the past had available a source of ultraviolet which he should receive if he were to work under the best conditions from a standpoint of maintaining health.

Artificial light sources or lamps have been designed to give this ultraviolet alone or with the proper amounts of heat and visible light to give radiation very much like natural sunshine.

These lamps have been used for medical purposes for many years. They are widely used for treating rickets, tuberculosis, skin diseases, and some other diseased conditions. These uses, while they might come under the subject of the paper will not concern us at present because they are individual medical treatments that can properly be conducted

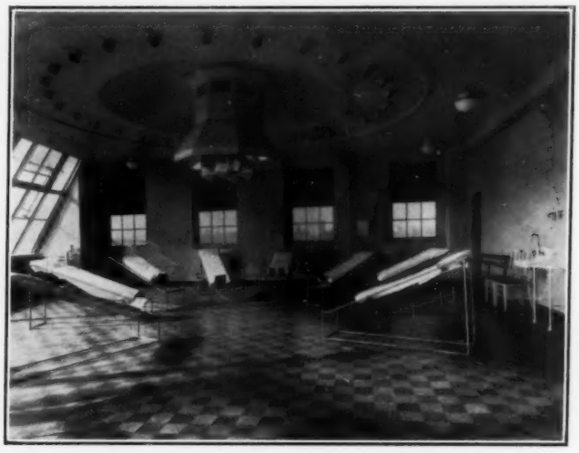


FIG. 2.

only by the physician in charge. Rickets, although most closely identified with ultraviolet, involves chiefly children and infants, and therefore, is not of direct application to the iron and steel industry.

We find that laboratory experiments on small animals show that exposure to ultraviolet lamps increases the ability of these animals to resist disease. Rabbits or guinea pigs in some of these experiments were kept under fairly good conditions. Some were exposed to the radiation from these lamps; some were not. The two lots always lived under identical conditions except that some received light treatments; the others did not.

These various lots of animals were then exposed to various kinds of disease germs. Ordinary guinea pigs treated with sunlight were better able to resist diphtheria and tuberculosis and rabbits became more resistant to typhoid and to the pus-forming bacteria, staphylococci, such as is found in some forms of blood poisoning.

These experiments did not show that these animals were absolutely immune to these disease forming bacteria, but they were more resistant to them. They could withstand larger quantities of these bacteria.

Further experiments in medical schools have shown that human beings with anaemia or abnormally low numbers of red corpuscles in the blood have returned to normal after exposure to artificial sunshine or to ultraviolet.

These experiments tend to give definite evidence of the manner in which artificial sunshine is an aid

to health. It would seem then to increase our resistance to disease and tend to maintain normal health.

One of the most common and wide-spread diseases that disturb the health and efficiency of otherwise healthy people is the "common cold." These colds are most common in those places where we get least sunshine, and in the Winter when less sunshine is available. Since exposure to artificial sunshine increases the resistance to other diseases, it is reasonable to expect that it would increase the resistance to colds, and therefore, reduce their number and severity.

Various experiments with different groups of people show this to be the case.

For several years, Cornell University has irradiated groups of students with these health lamps. They have found that ten to fifteen minutes exposure twice a week reduces the number of colds 40 to 60%.

Recently in London, 100 children were studied in an experiment of this type. Those who received two twenty-minute exposures twice a week gained in weight, had better appetities, slept better, and were less subject to colds. The difference between the treated and untreated groups was very great in this respect.

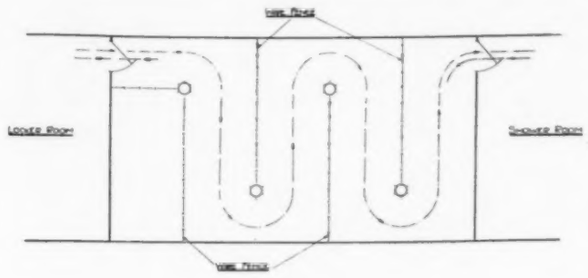


FIG. 3.

An earlier experiment in England by Dr. Scott who conducted experiments on London women who worked in various factories and offices gave the following results: In two years the light treatments were given through the six months of Winter of 1926-7 and 1927-8. The time lost by the women averaged four and three days, respectively, each Winter compared with seven and a half and nine for the two previous years.

All these experiments indicate that lost time and sickness can be reduced to half the present normal by these light treatments. Gain in working efficiency during the rest of the time is difficult to measure, but it must be increased.

Fig. 2 shows an excellent industrial hospital type installation where the employes receiving the sunbaths can lie down for a few minutes while receiving the exposure.

In Fig. 3 a more simple and inexpensive arrangement is indicated. Here four bare arcs are hung in a passage connecting locker and shower rooms. The room illustrated in the diagram is thirty-five feet by twenty. Panels of wire fencing establish a "W"-shaped course through the room approximately 100 feet in length. In traversing this room, the body would be exposed to radiation from all sides and approximately 45 seconds would be required to walk, at normal speed, the length of the room and back. At the intensity of light afforded by the four arcs in this arrangement, this time would afford ample radiation for the purpose of health maintenance without danger of over-exposure.

While this arrangement of lamps provides effective distribution of light, the efficiency of the installation could be further increased by covering the walls of the room with some ultraviolet reflecting material.

With such an arrangement of lamps, 1,000 men could easily be treated per hour as they were passing between locker and shower rooms.

From the facts that have been presented and the illustrations of actual installations, it is evident that not only the theory but also the practice of the use of health lamps to promote health and efficiency is established.

Discussion—Twin Motor Drive†

By R. H. WRIGHT*

J. H. Van Campen, Chief Engineer, Youngstown District, Republic Steel Corporation, Youngstown, Ohio.

R. H. Wright, General Engineering Department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

G. R. Carroll, Electrical Superintendent, Jones & Laughlin Steel Corporation, Aliquippa, Pa.

W. B. Shirk, Steel Mill Division, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

J. H. Van Campen: I would like to ask Mr. Wright if in the smallest blooming mill it is economical, in his opinion, to put in the twin motor drive.

R. H. Wright: It is rather difficult at the present time to say what is the smallest blooming mill to which twin motor drive can be applied economically. This will depend largely on the tonnage rolled in the mill. On small mills, say between 20" and 30", the cost of a twin motor drive might be greater than for a single motor and pinions. If such a mill were to operate consistently below potential capacity, the twin motor drive might be considered uneconomical. Where conditions make it possible to take advantage of the possibilities for increased output, the twin motor drive would probably be economically

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advantageous. In some cases, because of space limitations, there might be mechanical difficulties in applying twin motor drive to a mill with small rolls, but so far it appears that such cases will be rare.

J. H. Van Campen: Is it possible to put the twin motor drive on a 40-inch mill?

R. H. Wright: Yes.

J. H. Van Campen: What percentage would you say would be the additional cost of the twin motor drive over the single motor drive?

R. H. Wright: We are at present unable to give any general figures on the comparative costs of the electrical equipment for twin motor drive and single motor drive. Increased cost of the electrical equipment for the twin motor arrangement is of course offset by the elimination of the pinions.

G. R. Carroll: We all know that ingot dimension and diameter of rolls gives us distance between roll centers. Is this linear dimension between roll centers a determining limitation to the application of twin motor drive? To cite an example, if a 54" mill can be driven by twin motor drive, would we find that a 44" mill could not be so driven, or would a 36" mill be out of the picture?

R. H. Wright: Do you refer to the horsepower capacity or the mechanical arrangement?

G. R. Carroll: I want to know whether that would determine whether you have a single motor or a twin motor.

R. H. Wright: In the case of either of the installations just described it would have been possible to have used two 5000 HP. single unit motors rather than two double unit motors. With single unit motors it would have been practically impossible to install both motors on the same side of the mill, so the mill builder worked out a spindle arrangement which would have permitted the installation of the motors on opposite sides of the mill. This arrangement included provision for a quick roll change device. Single unit motors installed in this manner would have been built with larger diameters than the double unit motors selected for these two installations.

Most operating men probably prefer to have the complete drive in one motor house rather than to have two motor rooms. We feel that the arrangement selected is the logical one to use for high capacity drives.

G. R. Carroll: Is there anything to show whether there is any saving in power?

R. H. Wright: No, not as yet. The blooming mill has operated since late in December of last year. Due to business conditions, the mill operates each week at a rather low tonnage output so no accurate comparable power data has been collected.

W. B. Shirk: I believe I can give a few details regarding the overall saving in first cost of a 40" mill drive. It depends on the mechanical arrangement of the twin motor drive and the size of the rolls and spindles. We estimate an overall saving in first cost for the twin motor drive ranging from $10,000 to $30,000; comparing the cost of the twin motor drive with the cost of a conventional drive with pinions.

The Testing of Lubricants*

By E. S. GLAUCH†

The testing of Lubricants as referred to in this paper will deal primarily with greases such as used on rolling mills and other plant equipment.

Further, I do not intend to go into any discussion as to chemical analysis or methods of determining the various substances used in the manufacture of the lubricants. The tests will, therefore, be those which will determine lubricating qualities which, after all, are the most important; it being assumed, the lubricant being the product of a reputable manufacturer does not contain anything which would be harmful to bearings or other metal surfaces with which it might come in contact.

In the event the lubricant is to be used where high temperatures exist, it would be well to determine the melting point before making other tests.

The testing of lubricants for mill equipment was usually done on the production machines. The result in many cases would be, that due to the necessity for maintaining production, the test would not get the required attention so that it would be hard to arrive at a definite answer. Then again, in making tests of this kind, in many instances, the only accurate records kept would be of grease consumption.

This does not tell the entire story, as in the majority of cases, the effect on power consumption is of greater importance than the amount of grease used.

In addition to mill tests which the writer was making several years ago, with use of a Graphic Watt Meter, he felt it should be possible to make, at least, the preliminary tests on some machine not used for production purposes.

After investigating the various lubricant testing machines available, none appeared to meet the conditions required to duplicate rolling mill practice. Some of the existing machines were designed for light loads and oils, while others capable of carrying heavier bearing loads still did not provide for application of load in the same manner found on rolling mills.

For a test to be of real comparative value, it should be made under conditions as near to those under which the lubricant will be used in actual practice, as possible.

It was, therefore, felt advisable to design an entirely new type of test machine which would meet the conditions above-mentioned.

The machine can also be used in testing the

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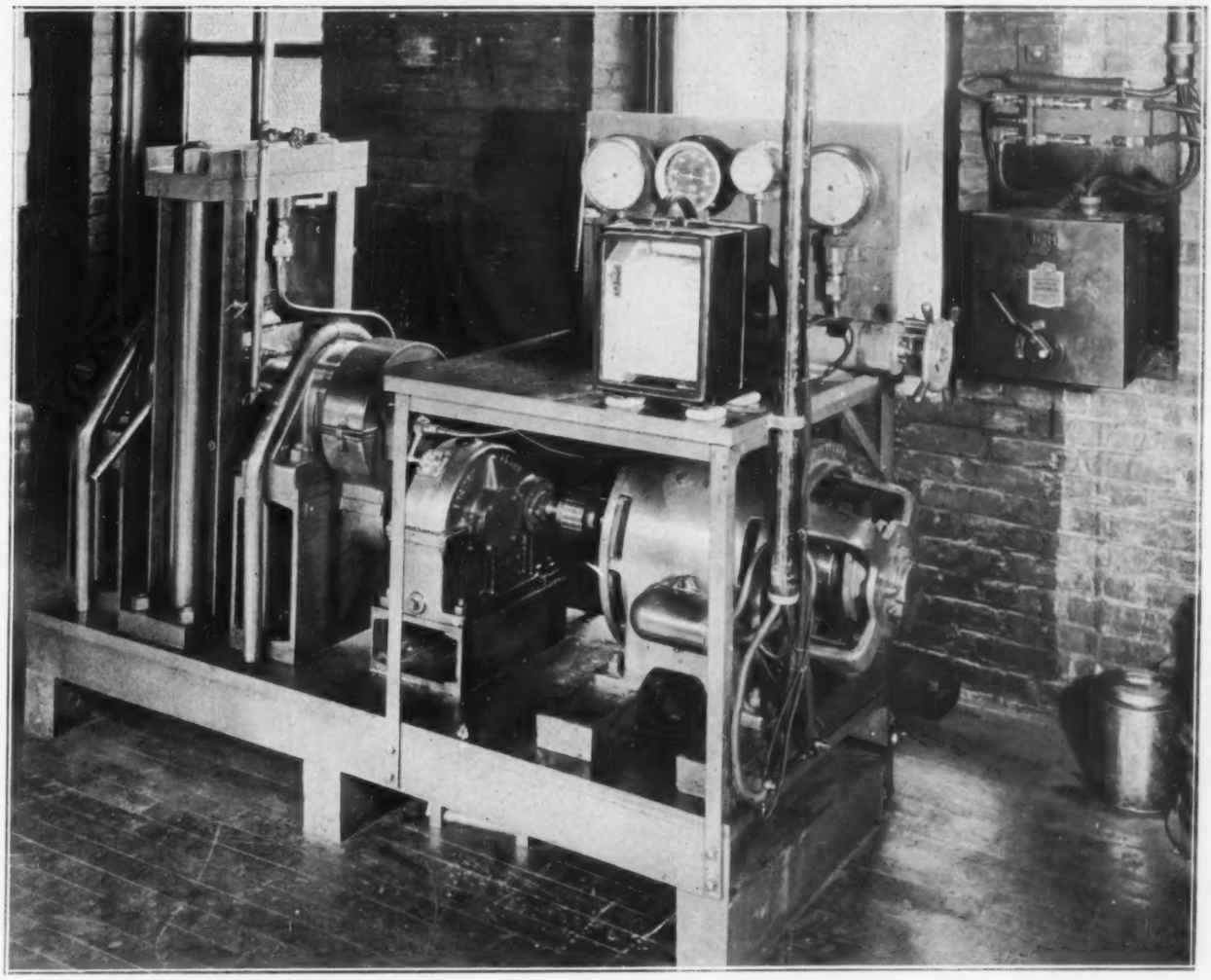


FIG. 1.

wearing and coefficient of friction qualities of various types of bearing metals.

Figure 1 shows the machine as constructed. This illustration plainly shows the general construction. The shaft on which the lubricant is to be tested, is mounted on two self-aligning roller bearing pillow blocks. On the central portion of the shaft, a removable sleeve is provided. This sleeve can be either iron or steel as desired. The bearing is held in a chuck or carrier. The shaft is driven through gears and reducer by a 7½ H.P. variable speed direct current motor. With gear ratios as built, speed of shaft can be varied from 85 to 190 R.P.M. To secure other speeds, it would only be necessary to change the gear ratio between the reducer and the shaft.

The bearing is loaded by means of a hydraulic cylinder or jack, and load is measured by a pressure gauge mounted on an instrument board. Figure 1 plainly shows the instrument panel which contains pressure gauges, thermometers, revolution counter and Graphic Watt Meter, all of which are used in compiling test results.

The lubricant to be tested can be applied in the manner in which it is to be used in mill practice, that is, if a heavy roll neck grease is to be packed in open bearings, same can be done on test machine. Block greases can also be tested and greases for pressure system can be used, as several types of equipments for feeding pressure greases are available.

When testing pressure greases, same can be fed directly to the bearing, or through a wiper box, if desired.

The procedure the writer has been using in testing roll neck greases is as follows:

After thoroughly cleaning shaft and bearing of any previous lubricants, the material to be tested is then applied. Thorough cleaning of shaft and bearing is especially important. The machine is then brought up to the desired speed and allowed to operate for sufficient time to properly distribute the grease over the bearing. If in practice water is to be applied, then water is used on tests.

The load is applied in a cycle similar to that found on strip mills, that is, load on for a period of four minutes, off one minute, with a five minute period between change in loads on bearing.

Readings are taken with loads on bearing obtained by applying pressures of 1000, 2000, 3000,

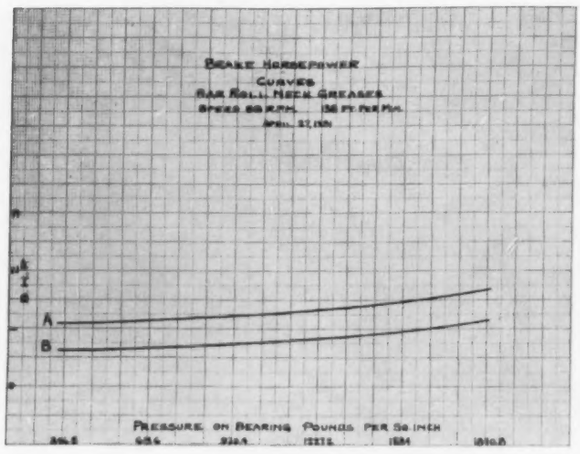


FIG. 2.

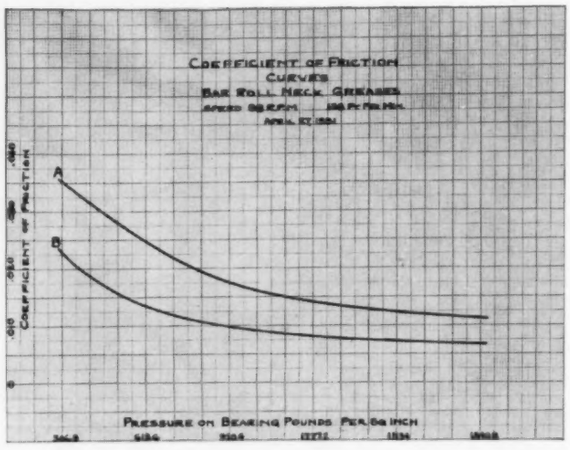


FIG. 3.

4000, 5000, and 6000 pounds per square inch. The resulting bearing loads per square inch of projected area are as follows: 306.8, 613.6, 920.4, 1227.2, 1534, 1840.8. The results thus obtained, enable one to plot a curve from which comparisons can readily be made.

The load on the bearing is measured by pressure gauge as mentioned above. The power required to drive the machine is measured with a Graphic Watt Meter. The average power consumed with shaft loaded is converted into B.H.P. by multiplying by 1.34 and by motor efficiency at the load and speed as obtained from motor efficiency curves. The power required to drive the machine with no load, is also converted to B.H.P. Subtracting this from B.H.P. when loaded, we have a net B.H.P. figure which represents power required because of load on center bearing.

The load on bearing in pounds per square inch, is obtained by multiplying gauge pressure by 6.213 (area of cylinder in square inches) and dividing by 20.25 (projected area of bearing).

For quick comparison, the B.H.P. figures obtained as mentioned above, can be used and a curve, as shown in Figure 2, would be the result. However, as in tests of this type, results are usually given in terms of coefficient of friction; the writer also computes results in this manner.

The coefficient of friction is obtained by dividing force or friction by the total pressure on the bearing

$$f = \frac{F}{P}$$

Since we obtain, by meter readings, K.W., we then convert as mentioned above to B.H.P. (B.H.P. = K.W. x 1.34 x motor efficiency). Then, this must be changed to force in pounds. The speed of the shaft is obtained by multiplying the speed in revolutions per minute by 1.57, the circumference in feet. We can then obtain the force in pounds (F) by multiplying B.H.P. by 33,000 (One H.P. = 33,000 foot pounds), and dividing by speed in feet per minute (S). This can be expressed in a formula as follows:

$$F = \frac{\text{B.H.P. x } 33{,}000}{S.}$$

The entire calculation can be expressed in the formula:

$$f = \frac{\dfrac{\text{B.H.P. x } 33{,}000}{S.}}{P.}$$

where

f = coefficient of friction
F = force in pounds

TEST NO. | GRADE OF GREASE | MFGD BY

DATED TESTED | TESTED BY | CHECKED | SHEET No.

Time	Speed R.P.M.	Counter Reading	Room Temp.	Bear. Temp.	Gauge Press.	Load on Bearing	Meter Reading		Motor Eff.		Brake Horse Power			Coeff. of Friction
							Load	No Load	Load	NoLoad	Load	No Load	Net	

FIG. 4.

K.W. = kilowatts
B.H.P. = brake horsepower
P = total pressure on bearings in pounds
S = speed in feet per minute.

Figure 3 shows curves plotted in terms of coefficient of friction, using same test results used in plotting curves shown in Figure 2.

Figure 4 shows the form used for recording figures obtained when making test.

It has been found that tests not only give comparisons with other lubricants but observations indicate how the lubricant stands the action of water and heavy loads.

Up to this point, testing refers to that done on special testing machine and now, we will consider tests on mill equipment. The usual method would be to try the lubricant and if it appeared to work satisfactorily, it might be used for a longer period. Then, if records were kept as to power per ton of material rolled and grease per ton, a comparison could be made.

In some plants, however, records of this kind were not always kept up to date, and it would take, sometimes, several months to find that the change in lubricants resulted in an increase or decrease in power consumed.

The writer has a case of this kind in mind where a change was made and about six months later, it was found the power cost per ton had increased.

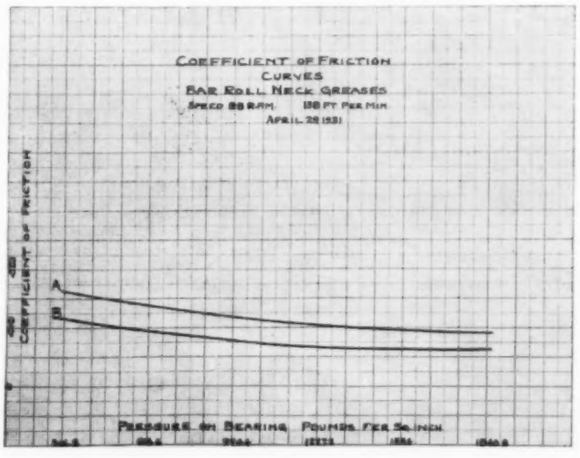


FIG. 5.

He was permitted to make a test and show that this could be brought down by substituting a lubricant which was found to be more suitable for this particular application and one which did not harden or stiffen excessively due to drop in temperature when mill was shut down.

For several years, the writer has conducted tests in mills using a Graphic Watt Meter to record results. By this method one can quickly note how lubrication effects power consumption and if grease appears otherwise to meet conditions, it will indicate whether a longer test is justified.

A test of this kind was made on a 22" three high mill. By averaging the curves with a rolling planimeter, it was found that the change in lubricant indicated a saving of 25 K.W. when rolling, and a 20 K.W. saving when idling.

A test taken on a cold strip mill where a saving of 19.3% or 26.8 K.W. was shown by one lubricant against another on the same work.

In order that the value of tests on testing machine, shown in Figure 1 can be noted, we have the results of a test on the machine as shown in Figure 5.

Here, it will be seen that Lubricant B has a coefficient of friction curve which averages 31% less than curve for Lubricant A. Now, compare these results with those shown in Figure 6 which is a mill test on cold strip mill using the same lubricants. The mill test indicates a saving of 25% or 36 K.W. in favor of Grease "B".

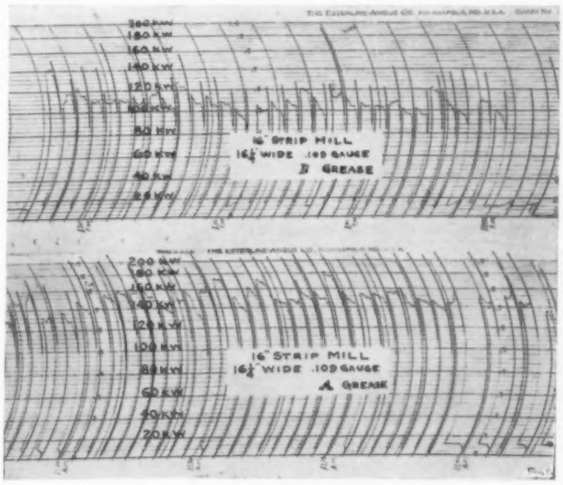


FIG. 6.

This gives a good comparison as to results of tests on testing machine and actual operation on mill. That the machine test shows higher saving in power than the mill test, is not at all unusual for in a rolling mill, there are always slight variations in operation.

The results are, however, such as to indicate what may be expected from a lubricant tested on this type of testing machine.

The writer might state that he does not claim that tests on the machine give results that are 100% theoretically correct, but they do give practical comparative figures, whereby lubricants can be judged. The results obtained on this machine cannot, of course, be compared with those one might obtain on some of the other types of oil or lubricants testing machines.

A Practical Sales Policy

By R. D. WOOD*

The following paper was presented before the American Institute of Steel Construction October 28 at White Sulphur Springs, W. Va. The fundamentals contained in this paper are applicable to any industry.

The following procedure should be followed as a matter of great importance by the sales department of each fabricator before actively taking up the sale of structural steel for any project:

I.—Preliminary Investigation

1. Location of work, name of project, owner, architect or engineer.
2. Credit (Owner—Buyer).
3. When will information be available so that material can be detailed and fabricated?
4. What delivery is desired?
5. When can it be delivered?
6. What date for completion of erection is desired?
7. When can erection be started?
8. Is there possibility of patent infringement?
9. Is open shop or union erection required or preferred?
10. Is inspection to be reasonable?
11. Will a reasonable amount of blue prints be required?
12. If the drawings are preliminary for pound price, is the information complete enough to show all complications which will develop?
13. Has party who is asking for bid authority to buy?
14. If bidding to a contractor, does he have a contract, or is he merely preparing an estimate?
15. From whom has buyer bought most recent requirements?
16. What competitors will bid on job?
17. What handicap do you have in cost, if any?
18. What advantage do you have in cost, if any?
19. If low figure is submitted, will it secure contract?
20. Will a competitor have the refusal of the job through friendship with the owner, architect, or engineer, interlocking corporation relationships, trade reciprocity, or local favoritism?

II.—Decision as to Whether or not to Estimate and Quote

With the information secured from the "Preliminary Investigation," an analysis should be made by a responsible officer of the company to determine the advisability of estimating and quoting.

Indiscriminate estimating and quoting are a disadvantage to a fabricator in two important respects:

1. The average fabricator, at the present time, is probably selling about 10% of the jobs upon which he quotes. Assuming that this is the case, the fabricators' sales expense can be reduced by the elimination of useless estimating as follows:
   - 10% Sales record—Reduction in sales cost — 0%.
   - 12½% Sales record—Reduction in sales cost —20%.
   - 25% Sales record—Reduction in sales cost —60%.
   - 50% Sales record—Reduction in sales cost —80%.
   - 100% Sales record—Reduction in sales cost —90%.

   In view of the elimination of shop work due to the rolling of special sections and larger sections, the sales expense of a fabricator is becoming an increasingly important item. Useless sales effort should be eliminated as a matter of economy.
2. The quoting of low prices by a fabricator who cannot sell the job, unless he makes a price which is lower than someone else will meet, is destructive to the whole industry, including the fabricator making these low prices. There is rarely justification for a low bid at any time, but a low bid which is made and does not secure the work is never justifiable, either as a matter of ethics or good business.

The following is good Trade Practice and its adoption will benefit each member of the industry:

A. Do not quote outside your proper market. You will not secure contract unless your price is too low.
   1. Confine estimates to jobs suitable to your facilities.
      (a) Large fabricators should not quote on small jobs.
      (b) Small fabricators should not quote on large jobs.
      (c) A fabricator who is unwilling or unable to enter into a contract excepting on an open shop basis should not quote on jobs requiring union erection, and vice versa.
      (d) If delivery is a prime consideration, a fabricator should not quote if he cannot make the required delivery.
   2. Do not bid in territory where your location is a sales handicap unless you have other strong advantages which will warrant an investment in an estimate.
      (a) If bidding outside the territory which you cover closely and there are other fabricators in that territory competent to do the work, be sure you have complete information as set forth in "Preliminary Investigation." Then determine honestly as to whether your bid will be given proper consideration before estimating and quoting.
      (b) Consider carefully the present desire of communities to keep work in its logical territory. A Bid from the outside will not be respected by the owner, architect, or contractor.

B. If a fabricator is convinced that a competitor will have the refusal of a job, he should not quote.

C. Where a general contractor secures a contract and previous to bidding has secured steel figures, no fabricator should quote him after the

* Mississippi Valley Structural Steel Company.

award has been made unless he estimated and bid to this contractor, the owner, architect, or engineer before the general bids were taken.

Conclusion: The decision as to whether or not to estimate and bid should be made by a responsible officer of the company with full knowledge of the facts surrounding the job, and with years of experience in competition. No company should allow an individual salesman to make this decision.

III.—Determination of Price

1. Secure complete plans and specifications, including general construction plans where complete bids are required.
2. Have estimate prepared carefully, showing estimated costs, taking into consideration all items set forth in the "Preliminary Outline of Cost System" by American Institute of Steel Construction in 1924.
   Include:
   1. Material
   2. Carrying charge—material from stock
   3. Handling
   4. Cutting
   5. Scrap loss
   6. Shop labor and burdens
   7. Drawings, labor and burdens
   8. Erection, labor and burdens
   9. Allowance for back charges
   10. Administrative expense
   11. Selling expense
   12. Organization dues
   13. Freight
   14. Interest

   (All of the above items requiring fixed assets should include proper depreciation and obsolescence charges).

This cost estimate should be prepared without regard to competitive conditions and should be based upon actual results of previous jobs. Add to this cost the percentage of profit necessary to secure an ample return to stockholders based on average volume of actual output.

Cost + Profit = Sales Price.

IV.—Proposal

1. Bids should specify they are in accordance with the Specifications and Code of Standard Practice of the American Institute of Steel Construction.
2. Delivery should be quoted from date of receipt of complete information, plus time necessary for approval of shop details. Erection time should start from date foundations are ready or steel is to be delivered, whichever is later.
3. All proposals should carry a date on which the quotation expires unless extended by mutual consent.
4. All proposals should be qualified as follows: The above terms of payment assume that the buyer has a favorable credit standing, and if investigations should indicate otherwise or if at any time there are unfavorable developments which, in the seller's judgment, affect the buyer's credit rating, the seller may require new terms of payment before proceeding further with this contract.
5. In bidding to general contractors before the letting of the general contract:
   A. Do not broadcast a low bid.
   B. Do not give a low bid to a contractor who will not agree to buy at your price if you are low. Whenever a contractor agrees to above and later you find he did not carry out his agreement, do not try it a second time. Try some other contractor.
   C. After general contractor has secured his contract, and you did not bid with him before the letting, do not try to take the work away from the fabricator whose bid he used in securing the work. Do not be a party to auction bidding where every bidder is told he is not low and encouraged to cut.

V.—Sales Effort

1. A fabricator should have confidence in his bid.
2. When notified by the buyer that his price is not acceptable the bidder should make a formal withdrawal of his quotation.
3. The bidder should not change his quotation excepting in consideration of a change in the plans, specifications, or conditions of the work.
4. When notified by the purchaser or by a competitor with confirming information of the existence of an agreement for a contract, the other bidders should discontinue their sales effort and take no action tending to break the agreement.

Good Housekeeping*

By A. V. BERQUIST†

The matter of good housekeeping may not be as serious a task in some plants as it is in others, dependent upon the product, process of manufacture, and the handling of materials.

An illustration of this is our Indiana Harbor Works which consists of three units: coke plant, steel plant and tin plate mills, completely enclosed by themselves and separated by trunk line railroads. The task of housekeeping in the coke plant and tin mills is a less serious problem due to methods of handling materials, continuity of production process and light weights of materials handled and individual responsibilities for plant orderliness as against a combination of departments, each handling material in a different state and degree; therefore, I will confine my discussion to the problem in a steel plant incor-

* Presented before Twentieth Annual Safety Congress, Chicago, Ill., October, 1931.

† Safety Inspector, Youngstown Sheet and Tube Company, East Chicago, Indiana.

porating such peculiarities as exist in the other two plants.

An analysis of housekeeping, good or bad, can be determined by the following causes:

Stocking of raw materials.
Processing of materials.
Transportation.
Maintenance.
Miscellaneous and non-essential material.

Materials such as coal, ore, stone, sand, lime, and other bulk materials should be stocked in bins with retaining walls of sufficient strength to withstand pressure weight.

Other materials such as billets, slabs, bars, rounds, pipe, etc., attention should be given to the foundation skids. Pipe or rail should not be used, as pipe caves under weight and rail is apt to warp and bend, particularly with semi-heated stock, so that in unhooking lifts man may have his feet under skid when lift is lowered and cause serious injury. Six-by-six steel bars, a slab, or twelve-by-twelve timbers are most satisfactory for skids for above purposes.

Spacing of lifts is dependent upon weight of materials. On lightweight stock we use 1 inch x 4 inch, 2 inch x 4 inch and 4 inch x 4 inch lumber blocking and short lengths of two inch pipe, where materials are bundled. Where round materials are stocked in piles, it is advisable to have cleats at end of skids. Where space is a factor, steel uprights embedded in concrete can be used for storage of long bars, rounds, pipe, etc.

Billets, skelp or other bundled stock and wide flat lifts should be cross piled and space of at least the width of bundle or stock left on edges of top row, so that crane chains or hooks striking on catching lifts would not pull material as readily as if piled close to the edge.

Where materials are stocked in yards, temporarily, or for repair or relining jobs, avoid piling over oil lines, gas mains or tunnels, sewers and manholes as there are dangers of breaks in lines or mains due to weight with subsequent settling, possibility of tipping piles and other hazards.

Brick, sacked cement and other materials should be cross piled and tied in, and in removing materials, it should be done one tier at a time, leaving enough on each corresponding tier as a step in case piles are high. In the unloading of materials from cars, lumber used for sealing or bracing should have nails bent over or removed as fast as unloading takes place. Straw packing or paper lining if not to be used for any other purpose should be taken to some isolated spot and burned. In removing materials from cars, it should be done so that weight is equalized on sides as otherwise there is danger of car tipping. The same principle applies to the loading of cars.

In all cases of piling materials, attention should be given to proper track clearances, and that no part of pile projects out to the extent that anyone walking by would bump into such projection.

In the processing of materials, there are opportunities of spillages that can only be avoided by proper construction and practice.

At blast furnaces or other departments where skips are operated, plate across bottom side of skip will catch stone scrap cinders, grease and other materials and return to skip pit, eliminating the danger of material falling on anyone walking underneath and also the necessity of cleaning up spillages.

Scrap chutes for dumping runner scrap will eliminate scrap falling between cast houses and cars. These also can be used to dispose of miscellaneous refuse from open hearth floors dumping to boxes. Bessemer vessel scrap chutes should be banked sufficiently at curves to prevent scrap flying from chute when charging. In addition, a hinged plate hanger can be provided in chute to retard speed of heavy materials such as bloom butts.

Having sufficient cinder ladles on hand to take care of cinder on flush or cast and filling ladle to certain maximum will eliminate spillages of cinder on tracks. Locking ladles with padlock arrangement eliminates the danger of tipping ladle while enroute to dump. At some plants cinder pits with flume arrangement eliminates or decreases the handling and use of cinder ladles almost entirely.

All departments handling hot metal should have a thorough system of inspection of ingot moulds for slag rims or butts, also of hot metal ladles and cinder pots for dampness, presence of ice or water, which would result in explosion if used, with subsequent burns, damage to equipment, hazards of equipment shortage and necessity of cleaning up, which constitutes a hazard in itself. If pigging a cast when mould strand has been idle, strand should be operated a complete revolution to drain off water or ice in cold weather. A salamander or fire under strand, kept burning in cold or wet weather, will assist in keeping moulds dry. Two angles placed underneath the strand at discharge end of machine, allowing sufficient clearance for stickers to drop and slide along bars to a point where they can drop in an enclosed area, eliminates possibility of pig falling on anyone who may cross under strand, and segregates stickers in one place instead of being scattered.

Spittings from Bessemer vessels accumulate on side walls and overhead structure work, which should be knocked down at frequent intervals to avoid the danger of it falling on men below. Incidentally the wearing of hard boiled hats painted white is a protective measure for pitmen against this ever present hazard.

Highlines should be provided with three foot sideboard extending at an angle of 45 degrees, preferably of steel to catch any materials that may fall from cars, particularly where passageways cross under highline.

An oxygen manifold system where any great amount of oxygen is used, will eliminate the danger of cylinders being scattered around, particularly where there is a danger of coming in contact with heat, hot metal or grease.

Pressure lubrication, roller bearings on equipment, oil pressure feed system on roller lines, spindle bearings, etc., have reduced oil and grease conditions to practically zero. However, in the old type mill we still have the hand system of oiling to contend with. Oiling of overhead cranes, crane should be spotted

so that it is not directly over passageways, stairs or landings. Proper attention to the application of oil or grease by oilers with proper type tools for each job will reduce overflows and spillages. More attention to the renewal of worn bearings will probably more than save the cost of change, in lubrication and decrease the slipping hazard. We all know that a sieve will not hold water. The use of oil-proof guards will also reduce the oil and grease hazard and lengthen the life of equipment.

Drip pans filled with sand, if oil is not to be filtered will keep oil from running out on floors.

Tanks for fuel oil, tar, benzol or other flammable liquids should be dyked or set in concrete base with retaining walls to dam or control the spread of such liquids to a confined area in case of leaks. Wherever possible piping for such tanks should be overhead instead of in tunnels so that in case of leak in line, it can be detected readily whereas a leak in a tunnel line, a sufficient quantity could accumulate to cause a serious fire before being detected.

Loading scrap, bloom butts, billets, crushed tin, plate, crushed pipe or cut off lengths, runner scrap and other materials for shipment to scrap yard or drop, attention should be given to trimming cars, so that no materials would project over side of cars to the extent they would strike buildings, columns or anyone passing, or fall off in transit, which creates a hazard to switchmen as locomotive footboards are often bent in due to scrap along tracks as well as breaking of cylinder cocks on locomotives. Also some of the material handled in this manner is of such weight that it is necessary to use a locomotive crane in removing from along tracks after having fallen from car due to poor loading.

Open hearth hobbs should be allowed to stand long enough to cool before transporting to dump as there is less likelihood of their breaking in transit and pieces falling along tracks.

Wire removed from bundled stock, the use of an 18 inch or 20 inch pipe about three or four feet long fastened to stand upright, will serve as a press for bundling wire, with the use of a tamp, and will eliminate pieces of wire lying around, creating a tripping or foot puncture hazard and will facilitate handling in returning for scrap.

Wherever possible and where scrap is of a size and nature to fit open hearth scrap pans and sufficient pans are available, it is advisable to use this method to handle scrap as it avoids rehandling and the minimizing of handling of materials tends to better housekeeping.

Provision should be made for storing polishing poles, pusher rods, tapping bars, guides, wedges, mould clamps, gaggers, rolls and all other spares so that when they are not in actual use they will not be scattered at random, creating tripping hazard, and unnecessary handling and haste in locating them when necessary for use.

In the handling of heavy spares, mill housing, rolls, etc., and in placing on floor with crane, the weight of the material and square corners will in time cause damage to floors if made of brick or concrete, which makes for bad footing in walking through mills or in an emergency in getting away from cobbles. This can be remedied by inverting used rail set in floor with bottom or flat side up flush with floor surface and spacing a foot apart to carry the weight of such material.

Transporting of materials by railway car, automobile truck, tractors or other conveyances requires well-ballasted tracks to eliminate derailments, particularly on hot metal or ingot runs as derailment may mean disastrous spillages.

Switching or handling of cars, road crossings should not be blocked by cars; discipline should be effected for failure to clear cars on sidings creating hazard of "side swipes" and for pushing cars into building doors before being opened. Suitable track bumpers should be provided on stub tracks to eliminate pushing of cars off end of tracks, particularly on trestles. Where single steel bumpers are used in yards or in buildings, it is a good plan to paint them white so they are discernible at night.

Roadways and aisles should be kept in good condition, free from holes as they are often used as a passageway from one department to another by men as well as travelled by vehicles with loads. Dangerous corners should be well marked. An important reason for clear aisles, roads and passageways would be in the event of emergency such as fire. It might also be mentioned in this connection that all materials should be kept away from in front of fire equipment, hospital stretchers and electrical equipment.

With maintenance men, electrical or mechanical, a rule to remember with respect to housekeeping and orderliness is that a job is never complete until all guards have been replaced, old and excess materials, tools and equipment removed.

To my mind, the minor part of housekeeping and cleanliness is that of keeping the plant free of papers, old overalls, gloves, old tobacco cans, cigaret packages and other incidentals. Containers at various locations with a definite understanding that such articles must be placed in containers will practically eliminate such articles being strewn about. In the case of cigaret packages, a beneficial campaign can be carried on to deposit all empty packages in a container at the gate with the idea of stripping lead to donate to charitable organizations.

In connection with non-essential materials a survey of any plant will reveal articles on roofs, overhead iron work, crane runways, platforms and stairs that have absolutely no need of their being there and while not in anyone's path, may at some time be caused to fall and strike someone, causing serious injury so that housekeeping alone is not confined to ground conditions but to overhead conditions as well.

The discussion I have presented may appear to be one of materials handling more than housekeeping, yet in diagnosing housekeeping, one cannot gainsay the fact that housekeeping is almost entirely the outgrowth of materials handling, and the lessening or minimizing the number of movements necessary to the handling of materials is the essence of good housekeeping.

Hand Labor and Trucking*

By J. A. VOSS†

Handling of materials by hand cause more accidents than all machinery, therefore, this source of accidents are generally the safety man's greatest problem.

Handling material accidents can be classified as follows:

Piling and unpiling
Loading and unloading
Carrying
Lifting
Transporting by hand and power.

Many companies have found it of advantage to study the work of handling material by hand as thoroughly as time studies are taken on any kind of job. After observation it is often possible to formulate the safe way of performing a job. A slight change from the usual method of grasping a piece, carrying it, and setting it down, will often make for greater safety as well as greater efficiency.

There are many operations in industries which can be done only by human hands and human intelligence —plenty of such operations go around. The more we can relieve labor from handling heavy material by hand, the more we reduce the hazard of strain, flat feet and casualties resulting from over-tired physical condition. Reduction in numbers of material handling laborers, of course, reduces hazards in proportion to numbers.

Generally speaking, a job can be made safer where materials are handled by some mechanical device rather than by hand. We have found that wherever it is possible to substitute a conveyor, traveling crane, or hoist in place of manual labor or hand trucks for moving material, it results not only in a noticeable decrease in the number of accidents, but it also shows considerable saving in operating costs. The mere installation of these devices will not prevent accidents, for the operating conditions must be studied and safe practices and rules developed for the most advantageous use of this equipment.

So many elements enter into the causes of handling material accidents that this makes it almost impossible to attempt to cover the subject in a fifteen minute talk. I believe it would do all of us good to again carefully review Safe Practice Pamphlets No. 54 and No. 55 as issued by the National Safety Council. These pamphlets cover the subject in a very thorough manner and the information contained therein can well be applied in our campaign for the elimination of handling material accidents.

When a man handles material in a wrong or unsafe way, it is not enough to say that he is careless. Generally the fact is that he has gotten into a habit, and the remedy is to teach him the good and safe habit. Handling material is a process in which the organized safety training and supervision of workmen are particularly necessary.

Practically, everyone is more or less careless in the manner of handling material. It is an almost universal trait of the so-called human race, therefore we have two premises: first, that unless trained otherwise by persistent and insistent follow up on the subject, men will be careless in handling material; and second, that unless carefully handled and properly piled, material will fall, roll, slide, bounce, and perform other antics peculiar to their perverse nature. Consequently a definite campaign for the safe handling of material is as important as any subject to which a well-ordered safety department can devote its efforts.

The use of lift trucks is becoming more and more general in plants where the moving of heavy material is necessary, both as a matter of efficiency and safety. The use of such trucks for heavy lifting has done much to eliminate strains and hernias. Much unnecessary piling and repiling is eliminated through the use of portable platforms which are transported by low slung trucks operated by man power or electrically driven. Material piled on these portable stock platforms is easily transported from place to place by the trucks, and therefore, but one handling of the material is necessary. Elevating trucks find their place in many industries. They are in use not only in manufacturing departments but in warehouses and shipping departments where their value is demonstrated in piling heavy boxes, bales and other material which otherwise would be handled by hand.

Too often, accidents due to handling material are classified as accidents "incidental to the work." Responsibility—"Injured's." Recommendation to prevent recurrence—"Be more careful." The above is typical of many reports covering accidents caused by improper handling of material. Such accidents should be more carefully analyzed to determine the direct and indirect causes, and proper remedy to prevent recurrence should be recommended. Many handling material accidents are preventable by providing protective devices such as safety shoes, leggings, wristlets, aprons, gloves, etc., and wherever such devices are practical these should be provided.

Frequently the desired amount of storage space in warehouses and stock room is not available and the safety department must make sure that the piles are stable at all times and must frequently assist the operating department in determining safe methods of placing the material in piles and removing it from piles. This is very often an easy matter with bulk material, for the pile can be controlled by means of bins, with provision to remove the material from the bottom of the bin. With boxed, baled and barreled material, it is a different problem, and very often the hazards differ with the location and material. The principal factors to be considered are weight, size and construction of the individual package.

Good housekeeping has been a big factor in reducing handling material accidents. In those plants where especial effort is laid on keeping all aisles unobstructed, there has been a noteworthy decrease in accidents of this nature. All too frequently accidents occur because of inadequate equipment, inefficient methods and improper handling of material and

* Presented before Twentieth Annual Safety Congress, Chicago, Ill., October, 1931.

†Safety Director, Republic Steel Corp., Youngstown, O.

lack of education of the workmen. Analyze these causes.

A definite campaign to eliminate accidents resulting from the necessary handling of material will result, if intelligently carried out, in an improvement in working conditions, speeding up of work, and a marked reduction in such accidents, even if they are not entirely eliminated.

ITEMS OF INTEREST.

PERSONNEL CHANGES.

▲

James A. Bell, general master mechanic for the Illinois Steel Company, at Joliet, retired December 1, at the age of 70. Mr. Bell entered the employ of the company, which was then the Joliet Steel & Iron Company, in 1888 as a machinist. He was made general master mechanic in 1910.

▲

Philip King of the Pittsburgh District office of the Keystone Lubricating Company has been placed in charge of Steel Mill Sales in the Pittsburgh District. In addition to his new duties, Mr. King will continue to handle all mechanical work in this district. R. C. McDaniel, formerly in charge of Steel Mill Sales has been placed in charge of a new division in the Pittsburgh District.

▲

The Chicago office of the Shepard Niles Crane and Hoist Corporation has been removed from the People's Gas Building to their present address at 564 West Monroe street, Chicago. Walter B. Briggs is the district manager and associated with him is G. G. Robbins.

▲

J. G. Corrin, formerly sales manager of the Pittsburgh Transformer Company, and more recently sales representative of the Allis-Chalmers Manufacturing Company on the Pacific Coast, has been appointed as district sales representative of the Pennsylvania Transformer Company for the State of California. Mr. Corrin is located at 140 North Sycamore avenue, Los Angeles, Cal.

▲

Foote Bros. Gear & Machine Co. of Chicago opened on November 1, a new district office in Milwaukee at 231 Wisconsin avenue, Room 1418 Majestic Building, in charge of L. W. Erickson, representative.

▲

William H. Jacobi, formerly general manager of the Keokuk Steel Casting Co., Keokuk, Iowa, subsidiary of the Springfield Boiler Co., Springfield, Ill., is now affiliated with the Continental Roll & Steel Foundry Co., East Chicago, Ind., in the capacity of sales engineer, specializing in cast steel pressure vessels and fittings of all kinds, both rough and finished.

▲

J. P. Flippen, Oliver Building, Pittsburgh, Pa., has been appointed exclusive representative of the Hills-McCanna Co., Chicago, Ill.

WITH THE MANUFACTURERS

▲

The Century Electric Company of St. Louis, Mo., have recently issued a bulletin on their Slip Ring Induction Polyphase Motors, 3 and 2 Phase Constant and adjustable varying speed. Copy of this bulletin may be secured by writing the above company.

▲

The Bristol Company of Waterbury, Conn., are distributing Catalog No. 4001 describing Bristol's Free Vane, Air Operated Recorder Controller. Interested parties may secure copies of this new catalog by writing the above company.

▲

The Brown Instrument Company of Philadelphia, Pa., have recently issued Bulletin No. 11 on the Application of The Brown Flame Analyzer in Coal Gas Plants. Copies may be secured by writing to the Philadelphia office.

▲

Edwin L. Weigand Company of Pittsburgh, Pa., are distributing a very attractive 16-page bulletin No. C-108. The bulletin shows a complete line-up of easily-installed air heaters for all kinds of hard-to-heat places that are found in many plants and offices, as well as useful data on installation. Copies of this bulletin will be mailed upon request.

▲

The new condensed catalog of the Stoker Manufacturers' Association is now being distributed. This new catalog covers the most recent developments of the fourteen leading stoker manufacturers who produce, it is believed over 95 per cent of the stoker equipment installed in the country. Write to W. V. McAllister, Foot of Walker street, Detroit, Mich., for copies of this new catalog.

▲

Elliott Company have just issued a new bulletin O-1 on Motor Generators. This 12-page bulletin is well illustrated showing installations and performance charts. Copies may be obtained by writing the Electric Power Division at Ridgway, Pa.

▲

"Recording Instruments CD Type for Alternating and Direct Current" is the title of the new 20-page Bulletin GEA-1061D just off the press. Copies of this interesting bulletin may be obtained by writing the General Electric Company at Schentectady, N. Y.

▲

Magnet Bulletin No. 125 has just been issued by The Ohio Electric Mfg. Co., of Cleveland, O. It is a 12-page bulletin and contains many photographs of installations. Interested parties may obtain copies by writing the above company.

Rockbestos Products Corp., of New Haven, Conn., are distributing a new bulletin No. 10-A on insulated wires and cables. Copies of this new bulletin will be mailed upon request.

▲

The Wellman Engineering Company of Cleveland, Ohio, announce that they have acquired by purchase, the Clam Shell Bucket and Heavy-Duty Trailer business of the G. H. Williams Company of Erie, Pa., including their good-will, drawings, patterns, inventions, patents, etc., and that the engineering, manufacture and sale of these well-known Williams buckets and trailers will be immediately transferred to the Wellman Engineering Company plant in Cleveland.

▲

The DeLaval Steam Turbine Company, Trenton, N. J., have just issued a catalog No. B-3 covering DeLaval Balanced Single Suction Series Pumps. A two-stage pump having single suction impellers placed back to back, that is, with the suction openings facing toward the ends of the shaft is described in this catalog. The new pump is hydraulically balanced just as in a single stage, double suction pump and has but two pairs of wearing rings the same as the single stage pump. For copy of this bulletin write to H. L. Watson, Sales Manager of the DeLaval Steam Turbine Co.

▲

Electro-pneumatic control equipment costing $1,230,000 has been ordered by the Board of Transportation of New York City from the Westinghouse Electric and Manufacturing Company. This control apparatus will be used on the 500 new subway cars needed for the city's expanding rapid transit system which is a part of the bililon dollar traffic and transportation program. The total cost of these cars with their equipment is more than $14,000,000.

▲

An instrument has recently been developed which reads illumination intensities with the same ease and facility as reading ammeters and voltmeters. This instrument was developed by the Weston Electrical Instrument Corp., of Newark, N. J., and is known as their Model 603 Illuminometer. Bulletin on this Illuminometer may be obtained by writing above company.

▲

The Trumbull Electric Mfg. Co. in Plainville, Conn., are pleased to announce the addition to their line a Combination Range and Entrance Switch with Branch Circuit Cutouts.

This device can be furnished in accessible or sealable main fuse types.

The entire device is in one box having two sections, each section having a separate cover. The upper section contains a fusible main switch, 3 Pole, 2 Blades, 2 fuses and a neutral terminal and the lower section a 2 Pole, 60 Amp. Dead Fuse puller and either 2, 4 or 6 branch cutouts.

▲

An announcement of a new motor starter now built by The Electric Controller & Manufacturing Company of Cleveland, O., has just been made. It is known as the "No. 1 Type ZEO Across-the-line Explosion-proof Starter" which has been officially approved by the Underwriters' for Class 1, Group D hazardous locations.

▲

The Roller-Smith Company, 233 Broadway, New York, announces a new bulletin and three new devices as follows:

1. Bulletin No. 160 covering alternating current portable instruments.
2. The Type T Mounting Base as covered by Supplement No. 1 to Catalog 48.
3. The Surface Tension Balance as covered by Supplement No. 1 to Bulletin No. 240.
4. The Type HTD-2 Circuit Tester as covered on Page 2 of Supplement No. 2 to Bulletin No. 300.

Copies of these four pieces of printed matter may be obtained on request.

▲

The General Electric Company announces a new line of shoe-type, weatherproof, Thrustor-operated brakes for alternating-current motors on mill, crane, hoist and similar applications where severe service requirements must be met. These brakes provide quick, cushion-like braking in either direction of rotation with either light or heavy loads, and are adjustable for braking torque over a wide range.

▲

The Chicago office of Surface Combustion Corporation has contracted with the Inland Steel Company to build two Mantle Recuperators, to be used on 14" Billet Mill Furnaces, already in operation at the Indiana Harbor plant. The recuperators are of the metallic type and are replacing regenerators.

OBITUARIES

▲

Lewis Taylor Robinson, engineer in charge of the general engineering laboratory of the General Electric Company, died suddenly from a heart attack at his home in Schenectady November 3. He was 63 years old, and had been in generally good health.

▲

Word has just been received of the death of J. D. Lindstrom in Sweden. Mr. Lindstrom was superintendent of Power Equipment at the National Tube Company, Ellwood City, Pa. He had been in ill health for some months, and some time ago left for Sweden in an effort to regain his health. Mr. Lindstrom had been an active member of the A. I. & S. E. E. since 1912 and the Association membership offers its sympathies and condolences to the relatives and associates of this prominent engineer.

▲

J. Walter Miles, who was recently placed in charge of engineering for the Canadian Westinghouse Co., Ltd., died at his home in Irwin, Pa., November 28.

▲

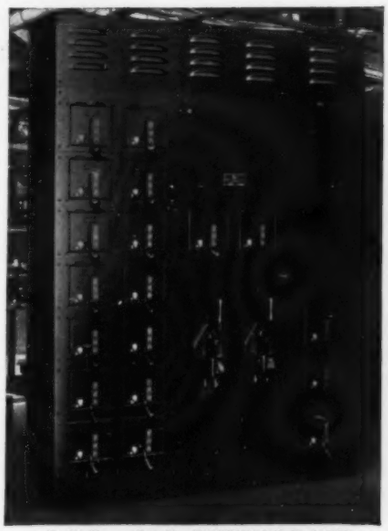
Andrew Telfer, formerly manager of the Pittsburgh mills of the National Tube Company, died at his home in Tampa, Fla., on November 17.

▲

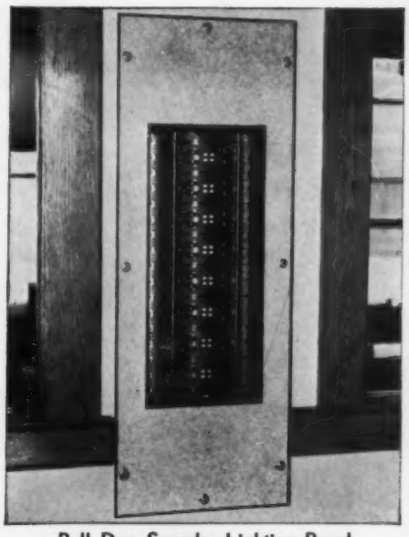
A. L. Culbertson, since 1927 manager of the furnace division of the Rust Engineering Company, Pittsburgh, died at his home in Pittsburgh, Pa., November 15.

Everywhere

that a safe efficient electric control is needed



Bull Dog SAFtoSWITCH-BOARD
incorporates Ball-Bearing Switches



Bull Dog Superba Lighting Panel
Special SurFlush Type

Bull Dog Safety Switch used
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SUPERBA
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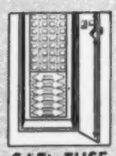
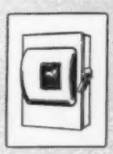


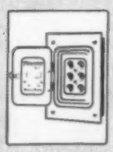
SAFtoFUSE
Feeder Panel



SAFETY SWITCH

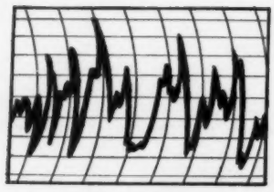
Bus-DUCT

Trol-e-DUCT

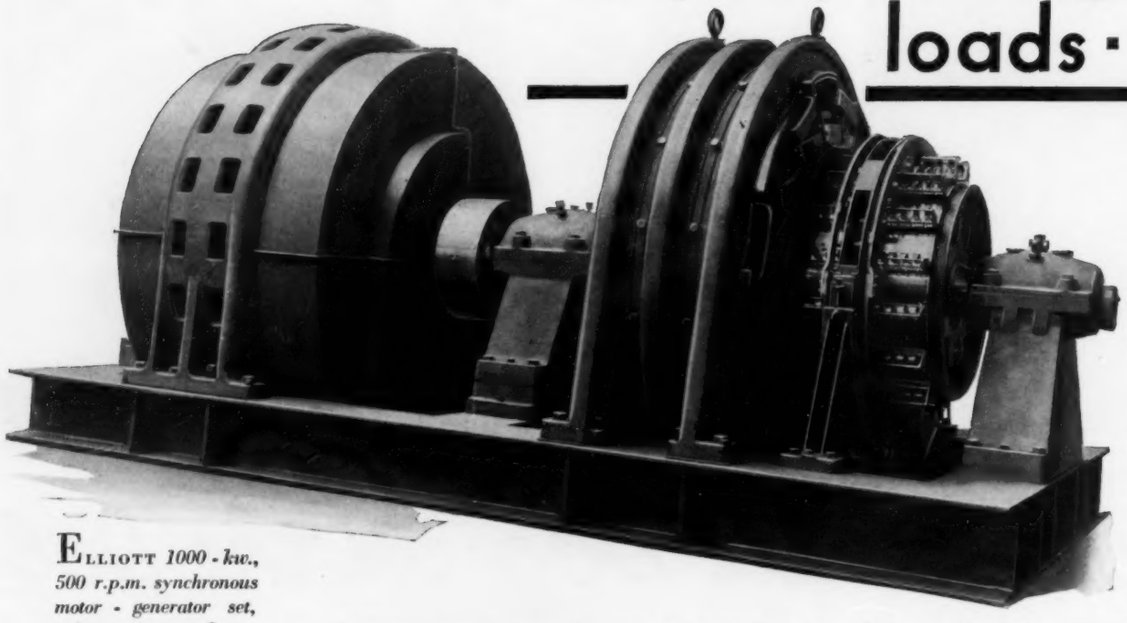


FUSENTER

SAFtoSWITCH-BOARD



Tough loads · · · ·
Heavy loads · · · ·
Rapidly changing loads · · · ·



ELLIOTT *1000-kw., 500 r.p.m. synchronous motor - generator set, using compensated generator. This set is in steel mill service.*

ELLIOTT *Motor-Generator Sets*

A motor-generator, in most cases, has a rather steady job. Under continuous operation, the smooth-running efficiency and reliability of Elliott motor-generators are appreciated by operators.

But when it comes to the tough, heavy and rapidly fluctuating loads, their extra in-built ability shows up clearly. Commutation, regulation and efficiency, are excellent even at fractional and overloads. Elliott M. G. sets are built to thrive under difficult service conditions, and they are "bears for punishment."

Elliott fully-compensated generators are accurately designed electrically to obtain perfect operation under severe load conditions. The compensating winding is proportionately distributed across the pole, exactly as required to completely neutralize and eliminate field distortion. In addition, the distinctive Elliott compensating winding has mechanical advantages.

Let us talk over with you the reasons for the superior performance of Elliott synchronous motor — fully compensated generator sets.

ELLIOTT COMPANY

PITTSBURGH, PA.

Electric Power Department RIDGWAY, PA.

District Offices in Principal Cities

O-940

"Time-to Modernize"

with the "CIRCLE T" LINE

EVERYWHERE throughout Industry, electrical circuits are now being controlled by Trumbull Safety Switches.

Electrical Engineers, and Experienced Electricians, know the value of their sturdy construction for long-continued service under severe conditions; and appreciate the features that make them safe to operate under rated loads.

Front Operated "R.B." Switches are the latest edition to the "Circle T" line, a new development contemplating the modernization needs of industry.

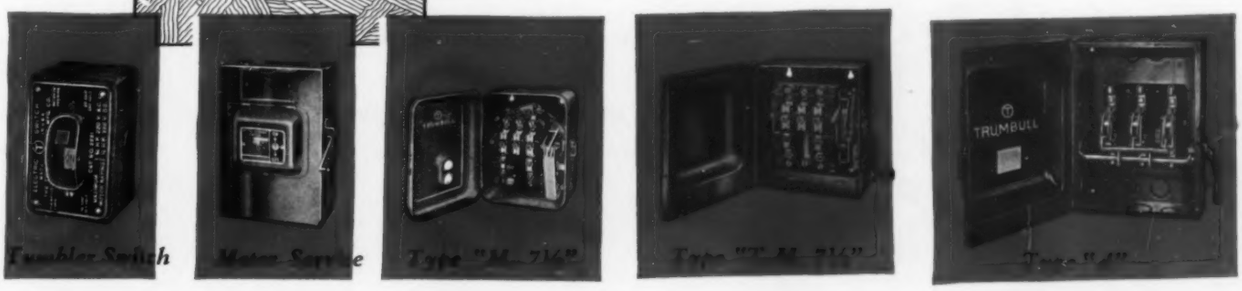
These new "Circle T" Switches earn their place in industry by providing a better and safer control for electrical circuits with a minimum amount of maintenance.

FEATURES

1. Ideal for close ganging on switchboards where space may be limited.
2. Lower half of cover hinged at center and interlocks with handle.
3. Handle end is slotted allowing for stick operation when switch is mounted out of reach.
4. Handle lays close to cover in both "on" and "off" positions.
5. Entire cover readily removable for switch inspection.

Complete description and listing of these switches and other Trumbull products, such as Type "A" Safety Switches, Type "C" Switches, Motor Starting Switches (Magnetic and Manually Operated) Open Knife Switches, Panelboards and Switchboards and many other Trumbull products, for safe distribution and control of electrical power are listed in Catalog No. 15.

We will gladly mail you a copy.



THE TRUMBULL ELECTRIC MANUFACTURING COMPANY

PLAINVILLE CONNECTICUT

New York
60 E. 42nd St.

A GENERAL ELECTRIC ORGANIZATION

Chicago
2001 W. Pershing Rd.

Philadelphia
511-519 N. Broad St.

Boston
1002 Statler Bldg.

Atlanta

San Francisco
432 Fourth St.

Detroit Branch
415 Brainard St.

Open letters about *New*

Mr. Manager . . .

On good, old-fashioned foundation stones of integrity, ability and honest pride in doing a good job, this organization has built up an unusual experience in our chosen specialty—new steel plant electrical systems and mill work installations.

We will undertake your work for a definite price, handling the entire electrical installation from source of supply to actual mill operation. The results will be responsibly guaranteed.

A Turner unit of trained engineers and electrical workers will fit harmoniously into your organization, and execute your work promptly, efficiently and economically.

Let us know your plans.

TURNER ENGINEERING COMPANY

TURNER

Mill Electrical Installations

Mr. Engineer . . .

The electrification of that new mill will be primarily an organization problem. Reliable, honest, experienced man-power! Where will you find it?

Turner has that man-power ready and waiting.

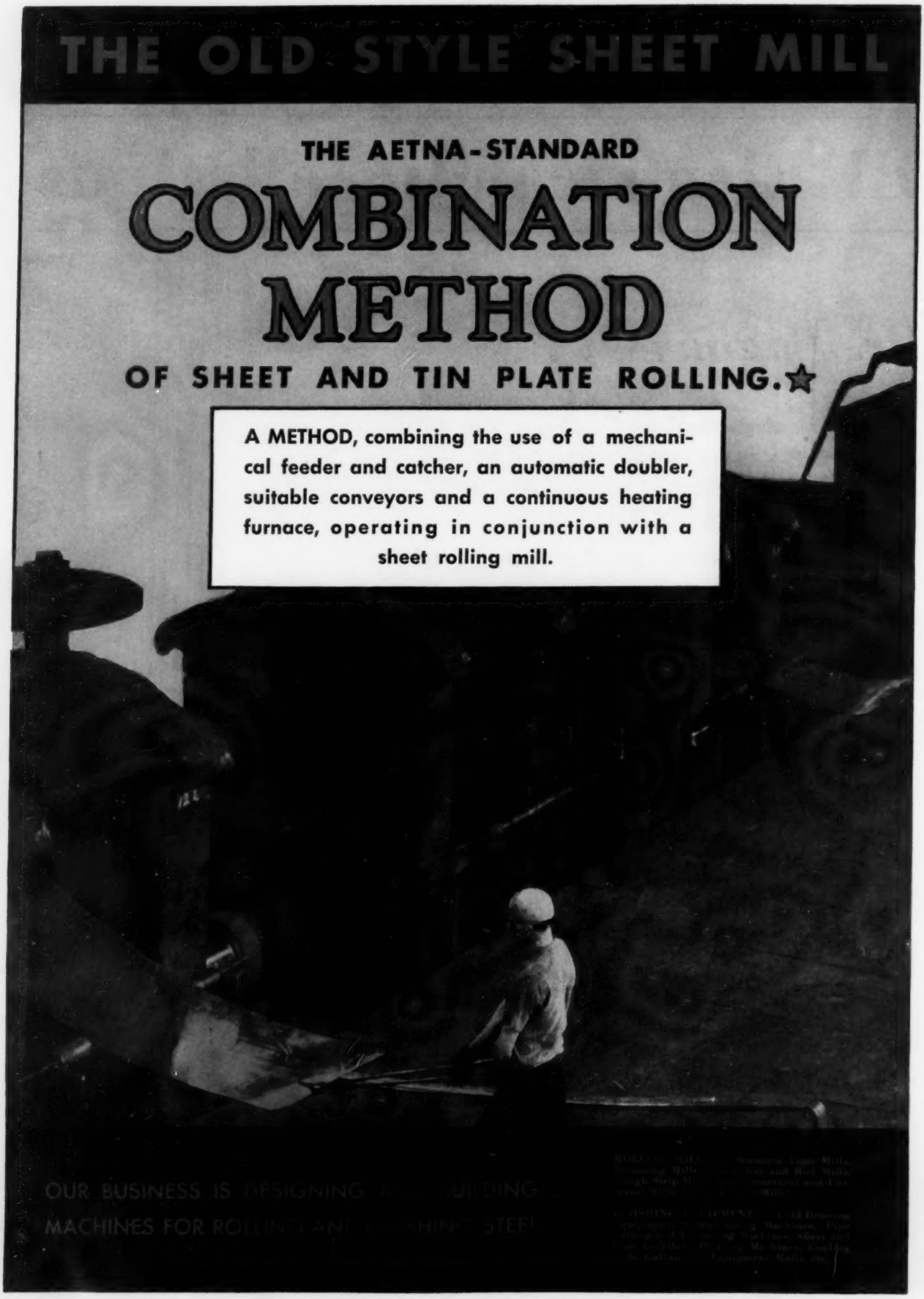
From field designing to job completion, a Turner unit will perform for you as it has performed for others in this, our chosen specialty. Under your leadership, Turner men will harmoniously co-operate with your organization, assume all responsibility, become liable for a complete job at a definite price, and guarantee satisfaction.

Any Turner client will tell you that you will be glad when we come in and sorry to see us leave.

Let's co-operate.

ENGINEERING COMPANY

DETROIT


THE OLD STYLE SHEET MILL
THE AETNA-STANDARD
COMBINATION METHOD
OF SHEET AND TIN PLATE ROLLING.☆
A METHOD, combining the use of a mechanical feeder and catcher, an automatic doubler, suitable conveyors and a continuous heating furnace, operating in conjunction with a sheet rolling mill.

CAN BE SAVED-BY THE USE OF-

LET'S SAVE THESE MILLS

▶ Old style sheet mills, like the ones shown here, can be modernized to the point where they will produce sheets that will meet all the demands of today's close competitive markets.

▶ These mills--when used in conjunction with the AETNA-STANDARD COMBINATION METHOD --will still retain their great flexibility of operation on either large or small orders--at a substantial reduction in operating costs.

A small investment is all that is required to modernize your present mills with this improved METHOD of rolling and to bring them into line with today's production methods.

★ THE COMBINATION METHOD as well as mechanical features are fully covered by patents and patents pending--either licensed or owned by the AETNA-STANDARD ENGINEERING CO.

The AETNA-STANDARD ENGINEERING CO. YOUNGSTOWN, OHIO.

A STATEMENT

of particular interest

TO

ELECTRICAL ENGINEERS

KEYSTONE GREASE No. 6 Light (*liquid*) is the most efficient lubricant for electric motor bearings of ring, chain, or collar type.

It has the required fluidity to be carried by the ring from the base reservoir to the shaft, but it does not thin out in operating temperatures to cause creepage onto the armature field.

Electrical engineers agree that the major cause of deterioration of armature windings is oil contamination. No. 6 Light eliminates the cause, and thereby lengthens the service life of the armature.

While the first cost of No. 6 Light is higher than engine oils used in some plants for motor lubrication, the heat-resisting quality of No. 6 Light which prevents creepage, also minimizes quantity consumed; this results in a decreased lubrication cost.

No. 6 Light has a low-cold test and works efficiently in cold weather in exposed places.

Altogether, this liquid grease offers a combination of advantages that highly commend it for the purpose specified.

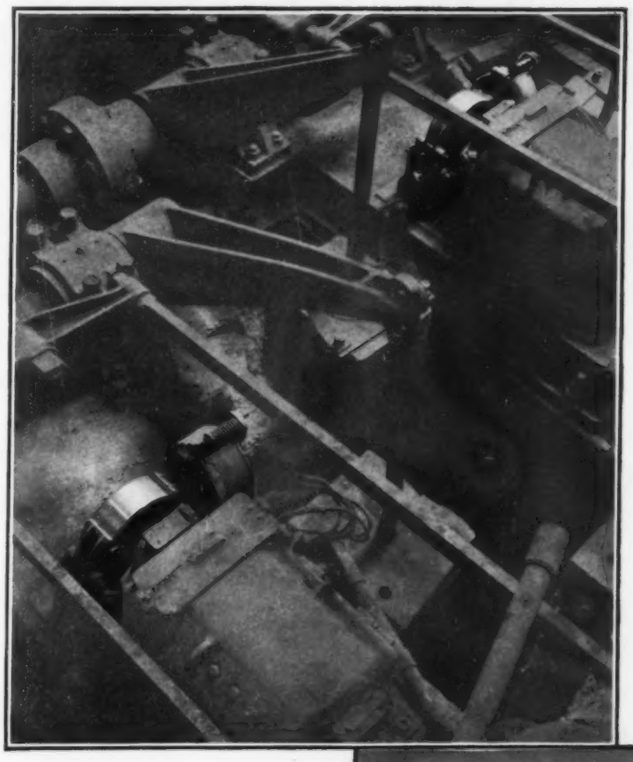
A Keystone Engineer is always at your service on any lubrication problem in any industry. Keystone Lubricating Co., 21st, Clearfield and Lippincott Sts., Philadelphia. Established 1884.

KEYSTONE GREASE KEYSTONE OILS

KEYSTONE *Lubricants*

©K. L. Co. 1931

$17,400 worth of Type WB Brakes use only $36.06 worth of renewal parts in 136 brake-years service



THIS is the record of operation of EC&M Type WB Brakes in a large steel plant. The actual amount of spare parts used, which was supplied by this customer, shows a maintenance cost for repair parts of only 27 cents per brake per year.

Many of these brakes are used on mill drives where operation is continuous. The remainder of the brakes are used on hard worked cranes such as ladle, hot metal, merchant and sheet mill cranes.

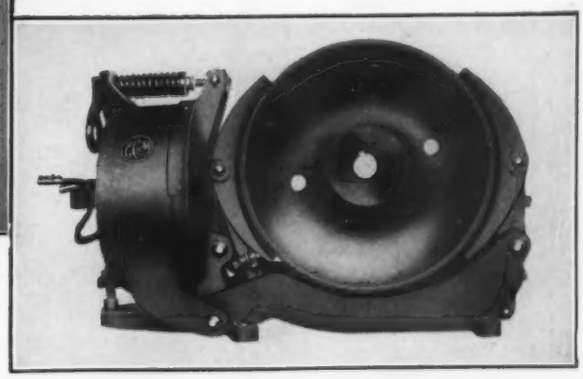
During this time, these EC&M Type WB Brakes have required only 3 replacements of Type WB moulded brake block linings; each replacement consisting of sufficient material for renewing 1 complete brake. Ask our nearest district office to show you these figures on upkeep cost. Check them with your maintenance costs.

A Good Brake never wears out

Particular attention has been given to the design of WB Brakes to meet this requirement. Non-rusting nitralloy steel bushings and case-hardened bearing pins are used on all sizes.

Moulded brake blocks accurately ground to fit the wheel, have constant frictional qualities throughout their entire thickness. Adjustments, when necessary, are easy to get at and so obvious that any mechanic will quickly understand them. Ask for Bulletin 1004-A.

- Only one adjustment for lining wear
- Only one adjustment for equalizing shoe clearance
- Only one adjustment for braking torque
- Only one operation (without disturbing a single adjustment) permits removal of motor armatures

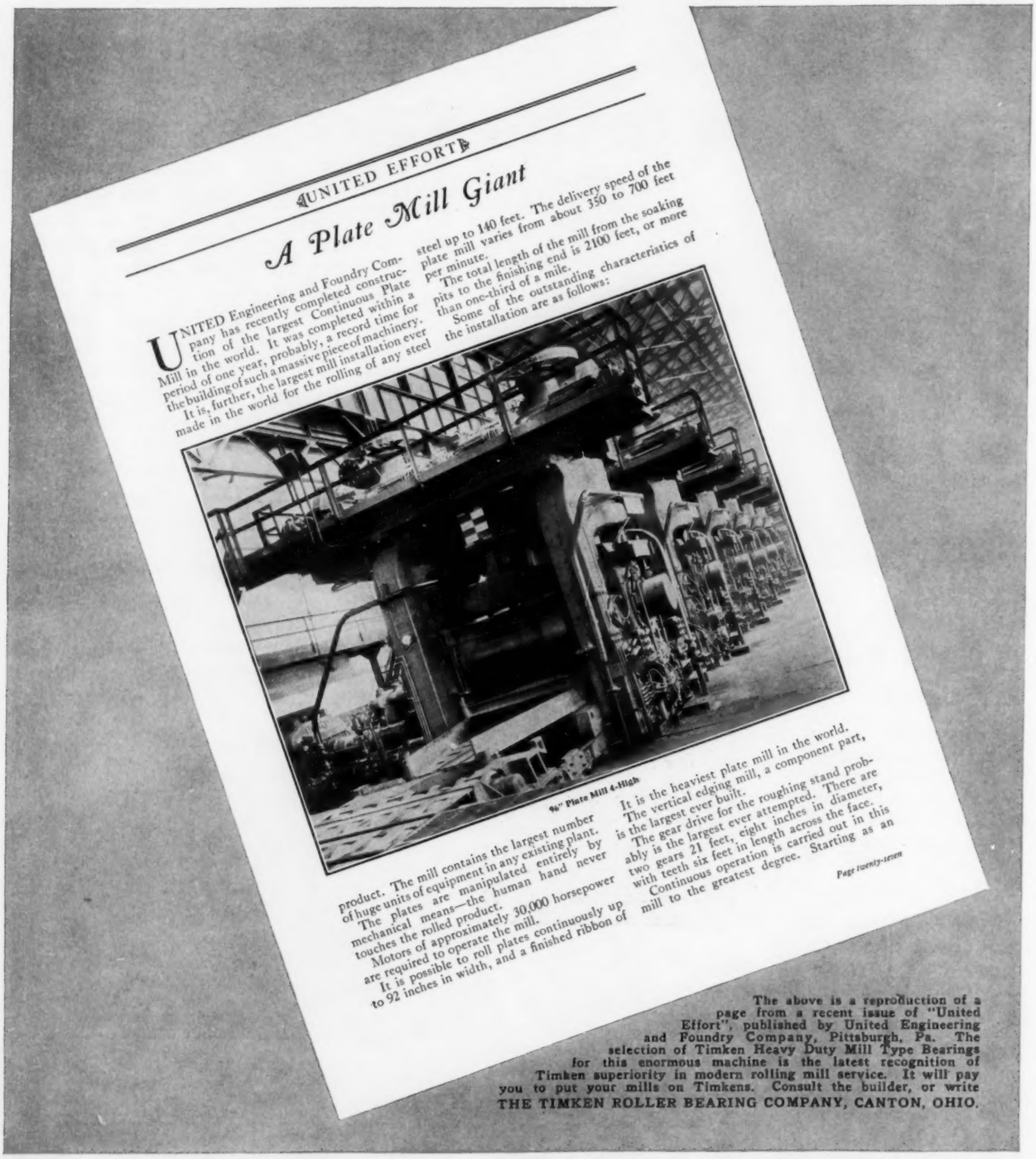


THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND, OHIO

NEW YORK-50 CHURCH ST.
CHICAGO-CONWAY BLDG.
DETROIT-DIME BANK BLDG.
BIRMINGHAM-BROWN-MARX BLDG.
CINCINNATI-1ST NATIONAL BANK BLDG.
ST. LOUIS-6926 MARQUETTE AVE.
KANSAS CITY, MO.-3241 THE PASEO.
LOS ANGELES-912 E. THIRD ST.
HOUSTON-P.O. BOX 4182
TORONTO-REFORD BLDG.
PHILADELPHIA-WITHERSPOON BLDG.
PITTSBURGH-OLIVER BLDG.
SAN FRANCISCO-CALL BUILDING
MONTREAL-CASTLE BLDG.
BUFFALO-888 COLVIN BLVD.
SEATTLE-2207-1ST AVE. SO.

The largest 4-high hot strip mill in the world has Timken Bearings weighing 3½ tons on each backing roll neck



UNITED EFFORT

A Plate Mill Giant

UNITED Engineering and Foundry Company has recently completed construction of the largest Continuous Plate Mill in the world. It was completed within a period of one year, probably, a record time for the building of such a massive piece of machinery. It is, further, the largest mill installation ever made in the world for the rolling of any steel product. The mill contains the largest number of huge units of equipment in any existing plant. The plates are manipulated entirely by mechanical means—the human hand never touches the rolled product.

Motors of approximately 30,000 horsepower are required to operate the mill.

It is possible to roll plates continuously up to 92 inches in width, and a finished ribbon of steel up to 140 feet. The delivery speed of the plate mill varies from about 350 to 700 feet per minute.

The total length of the mill from the soaking pits to the finishing end is 2100 feet, or more than one-third of a mile.

Some of the outstanding characteristics of the installation are as follows:

It is the heaviest plate mill in the world. The vertical edging mill, a component part, is the largest ever built.

The gear drive for the roughing stand probably is the largest ever attempted. There are two gears 21 feet, eight inches in diameter, with teeth six feet in length across the face.

Continuous operation is carried out in this mill to the greatest degree. Starting as an

Page twenty-seven

The above is a reproduction of a page from a recent issue of "United Effort", published by United Engineering and Foundry Company, Pittsburgh, Pa. The selection of Timken Heavy Duty Mill Type Bearings for this enormous machine is the latest recognition of Timken superiority in modern rolling mill service. It will pay you to put your mills on Timkens. Consult the builder, or write THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO.

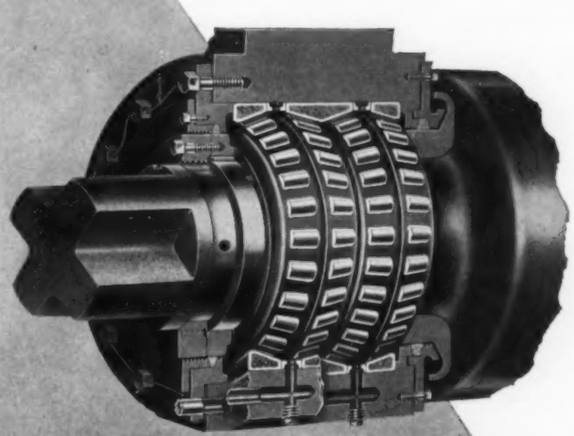
TIMKEN *Tapered Roller* BEARINGS

It's the *final cost* that counts

Timkens' first cost may be more, but it is the ultimate cost that interests the far-sighted mill operator—the cost of the bearings plus the cost of maintenance per ton of steel rolled. That—not the initial cost of installation—is the real issue, and the only safe measure of roll neck bearing value.

Here are the outstanding technical reasons for Timken superiority:

1. With Timken Bearings on roll necks, no auxiliary supports such as thrust bearings or thrust collars are needed. The Timken Bearing is geometrically designed to carry all thrust loads and all radial loads within itself.



Timken 4-row Type Heavy Duty Roll Neck Bearing. Bearing shown weighs 3½ tons.

Timken 2-row Type Heavy Duty Roll Neck Bearing. Bearing shown weighs 2½ tons.

2. Timken is the only type of bearing that can be set up with extremely close radial running clearance and maintained in that condition during its entire life. That means any clearance—from zero to the exact amount required for rolling any product. Close running clearance materially increases the shock capacity and life of the bearing.

3. The wear that occurs in a Timken Bearing during operation does not necessitate take-up any more frequently than a "non take-up" bearing has to be replaced. Thus the life of the Timken Bearing is much longer. This extended life represents years of added service . . . many extra tons rolled . . . uninterrupted operation . . . and thousands more dollars in profits.

Endorse the mill builders' judgment when buying new equipment—specify Timkens. The Timken Roller Bearing Company, Canton, Ohio.

TIMKEN *Tapered Roller* **BEARINGS**

ACCIDENT RISKS REDUCED

BY

"TOOL STEEL"

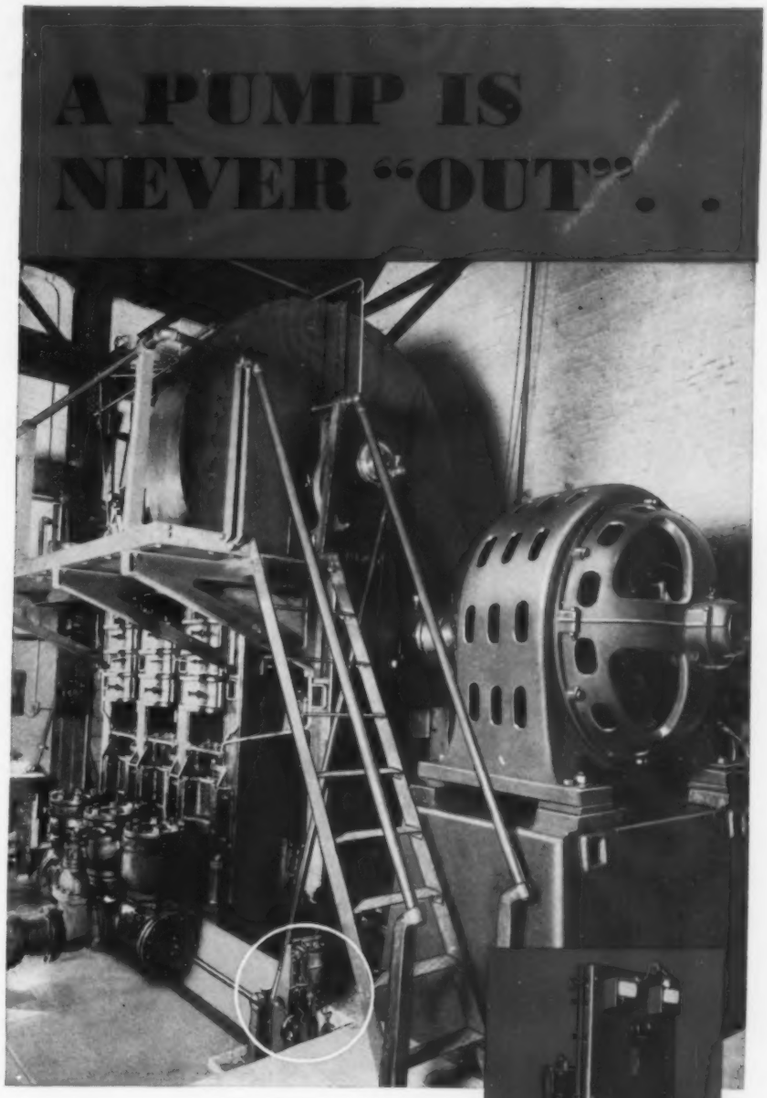
Specially Hardened and Toughened

Gears
Crane Wheels
Brake Wheels, etc.

They last much longer, are changed less frequently and
therefore reduce the hazard of accidents
when changes are being made

SAFETY FIRST

The
Tool Steel Gear & Pinion Co.
Cincinnati, Ohio



DRIVEN BY AN E-M SYNCHRONOUS MOTOR

A PUMP never interrupts production when driven by an E-M Synchronous Motor and E-M Control. Power dips won't stop it. If current fails completely the pumps start automatically as soon as production can start . . . the pump is controlled by push-button . . . manual loading is eliminated . . . automatic start and stop operation can be secured to maintain desired liquid pressure.

This is accomplished differently on different types of pumps. The installation above illustrates a typical method.

The reciprocating pump is equipped with a Holveck type automatic unloader, interlocked with the E-M *Field-Frequency* Control. If for any reason the motor operates at less than synchronous speed, the E-M *conscious** kick-off relay immediately unloads the pump and removes excitation so the motor will not "stall." With the return of normal conditions, or whenever the pump is started, the motor easily accelerates the unloaded pump, resynchronizes, and the pump is automatically loaded.

Every E-M motor ever sold was especially designed and built for its intended job. Attacking problems one by one has brought answers to them all—so that the power factor correction, efficiency, and low maintenance advantages of synchronous motors can be yours on any constant speed drive.

E-M Synchronous Motor Pump Drive in the plant of the American Cast Iron Pipe Company, Birmingham, Ala. Holveck type unloader (shown in the white circle) interlocked with E-M Control, prevents forced shutdowns.

The 64-page book, *"The Most Efficient Drive in Industry"* will explain ways an E-M Synchronous Motor can save for you. Write for a copy. ELECTRIC MACHINERY MFG. CO., 1337 Tyler Street, N. E., Minneapolis, Minnesota.

**Instantly* responsive to the electrical condition of the synchronous motor field winding.

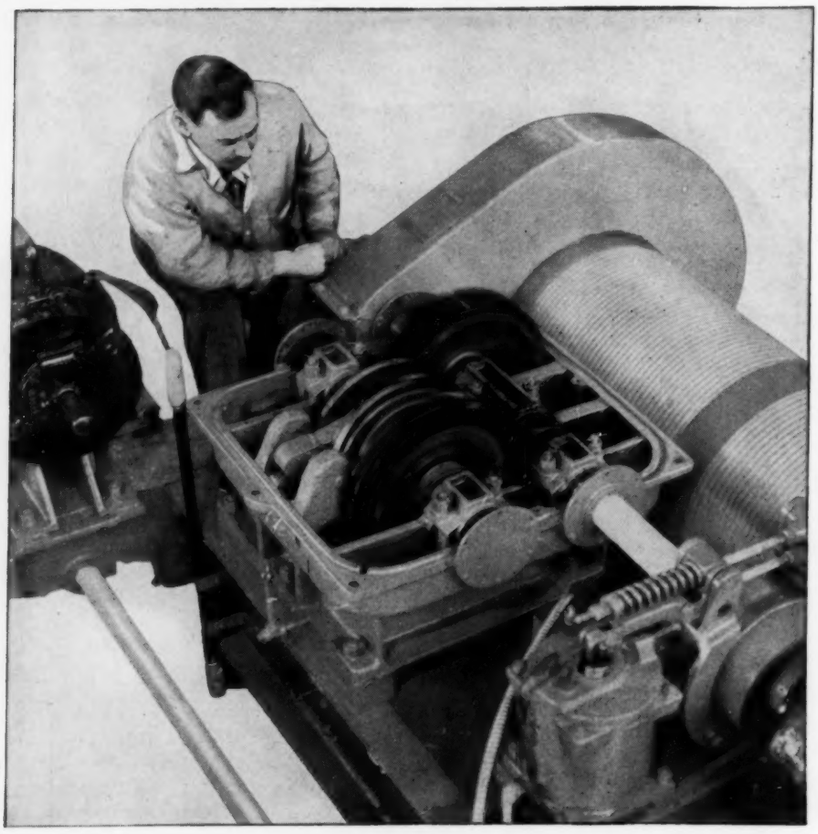
E-M *Synchronous* MOTORS

PROTECTED BY CONSCIOUS E-M CONTROL

(A-4255)

Watch these Gears in ACTION

they predict performance



REMOVE the housing cover from the high speed reduction-gears and load-brake of a Niles Crane Trolley. Throw the switch! Then watch the action of this mechanism which has been so enthusiastically welcomed by crane users.

Note the smooth, quiet action of the gears. They run in perfect mesh. It is the exclusive compact design of the Niles reduction-gear and load-brake unit that makes possible this perfect performance—and that keeps it so throughout years of service.

Shorter, hence stiffer shafts are used to carry the gears. Roller bearings are used throughout. They are located entirely within the housing and integral with it. Lastingly rigid support and perfect alignment for all moving parts is thus assured.

All gears run in a single bath of oil. As these gears revolve they whirl a continuous stream of oil into the bearings and the load-brake. Perfect lubrication for every moving part is made certain.

When you consider the purchase of a crane, bear in mind that the reduction-gear and load-brake mechanism is the very heart of a crane—the part that gets the most severe service. Bear in mind, too, that the Niles compact design has proven its capacity to give trouble-free performance with truly low cost maintenance.

Our Bulletins 100-N and 101-N contain many pertinent facts regarding this and other features of Niles Cranes. We would welcome your request for copies of these bulletins or for the visit of one of our representatives.

SHEPARD NILES
CRANE & HOIST CORPORATION
Main Office. 376 No. Schuyler Avenue, Montour Falls, N. Y.
Works: Montour Falls and Philadelphia, Pa.
Branches in Principal Cities

NILES CRANES

NATIONAL PYRAMID BRUSHES N C C STANDARD FOR 40 YEARS

. For severe conditions *in* steel mill service .

Mill type motors

Screw down motors

Reversing table roll motors

Crane motors

Variable voltage motors

Variable speed motors

NATIONAL Pyramid Grade 869 combines good commutating characteristics and ample carrying capacity with just enough cleaning action to maintain a well polished commutator, minimize maintenance expense and afford excellent brush life under the exacting requirements of heavy duty steel mill service.

There is a National Pyramid Brush for every type of service. Each grade is the product of practical engineering knowledge, extensive research facilities and forty years' experience in carbon brush manufacture. National Pyramid Brushes satisfy the demand of the steel industry for a high standard of reliability.

Insure the dependable operation of your mill by installing Grade 869 on your heavy duty motors.

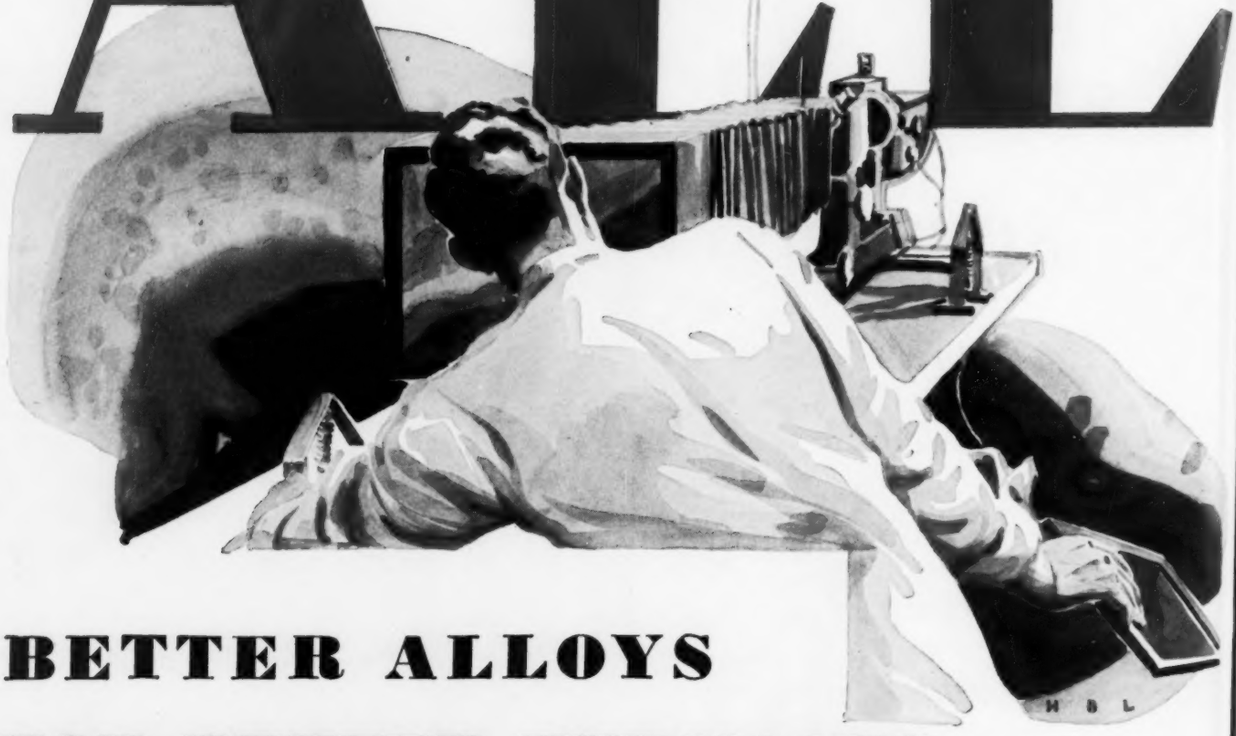
NATIONAL CARBON COMPANY INC.

Carbon Sales Division · Cleveland, Ohio

Unit of Union Carbide and Carbon Corporation

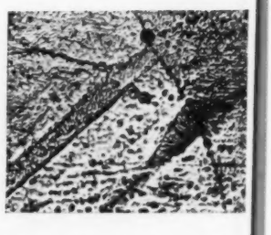
BRANCH SALES OFFICES: · NEW YORK · PITTSBURGH · CHICAGO · SAN FRANCISCO

ALL

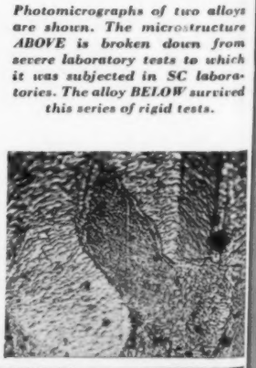


BETTER ALLOYS FOR BETTER FURNACES

The heat-resistant alloy steels used in Surface Combustion continuous furnaces conform to the most rigid specifications—subjected to unusual laboratory tests that reveal the slightest flaws and imperfections. For years Surface Combustion's staff of metallurgists—specialists in alloys—has studied, compiled and collected information. Working closely with alloy manufacturers Surface Combustion specialists have removed the uncertainties imposed by imperfect alloys . . . and have developed special heat-resistant steels that stand up under the severe stress of modern continuous methods. This is Industry's assurance against costly mechanical failure in the field.

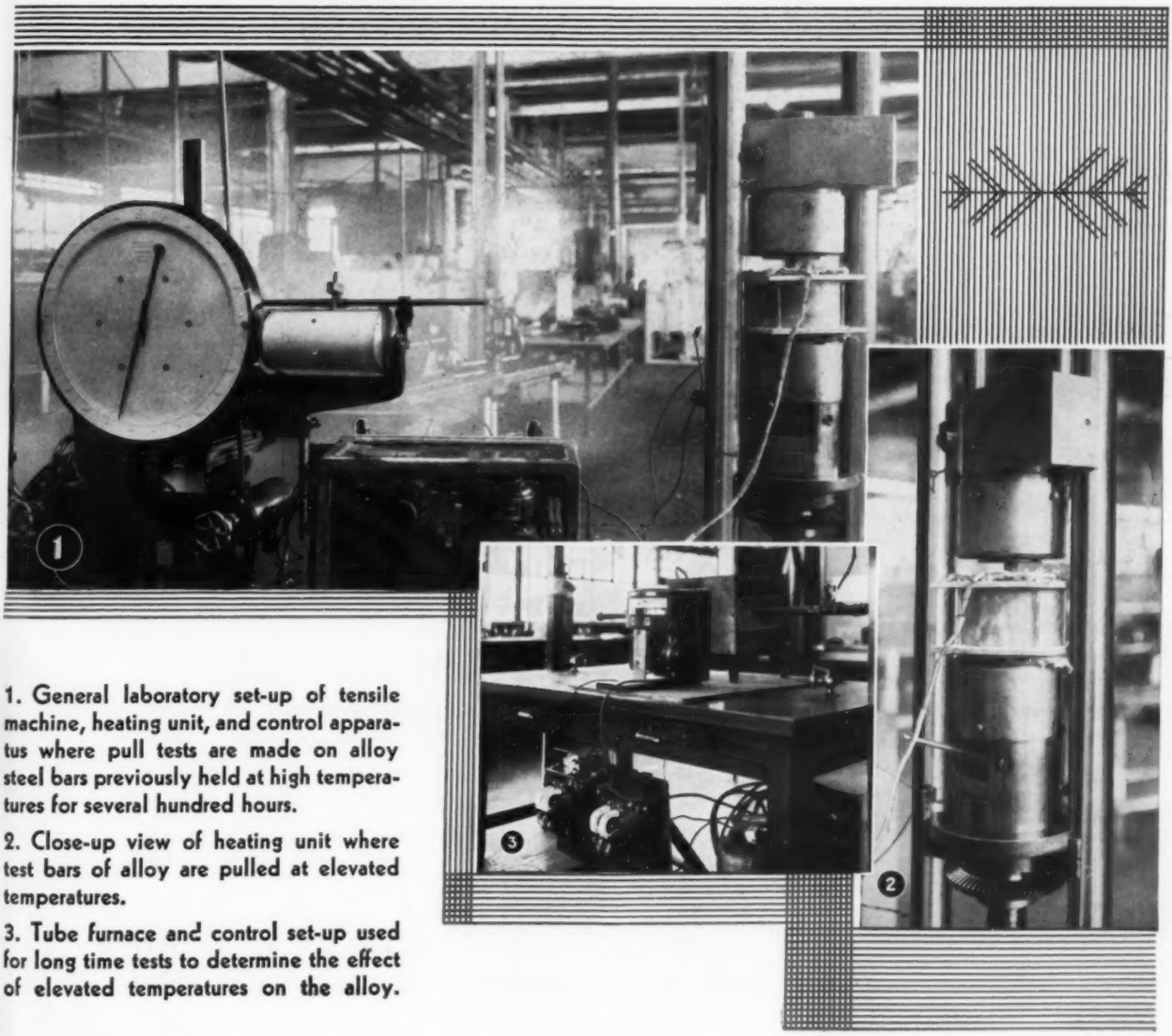


Photomicrographs of two alloys are shown. The microstructure ABOVE is broken down from severe laboratory tests to which it was subjected in SC laboratories. The alloy BELOW survived this series of rigid tests.



SC

OYS



1. General laboratory set-up of tensile machine, heating unit, and control apparatus where pull tests are made on alloy steel bars previously held at high temperatures for several hundred hours.

2. Close-up view of heating unit where test bars of alloy are pulled at elevated temperatures.

3. Tube furnace and control set-up used for long time tests to determine the effect of elevated temperatures on the alloy.

OPERATED BY HENRY L. DOHERTY & COMPANY

Surface Combustion

SURFACE COMBUSTION CORPORATION
TOLEDO, OHIO.

SALES AND ENGINEERING SERVICE
IN PRINCIPAL CITIES

BLISS

ROLLING MILL EQUIPMENT
FOR
HOT OR COLD ROLLING

MILLS

MILL REELS

COILERS

SLITTERS

WINDING REELS

LEVELING MACHINES

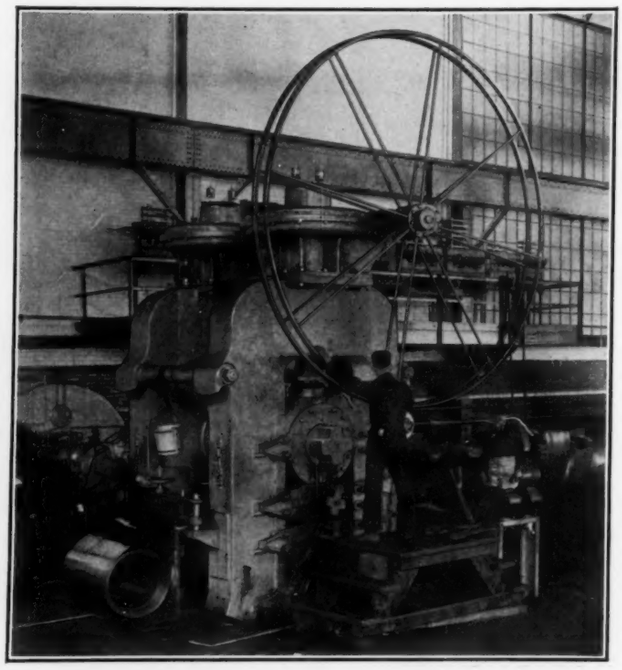
SHEARS

RECOILING MACHINES

SCRAP-BAILING MACHINES

ETC.

ETC.



BLISS FOUR-HIGH MILLS
ROLLER-BEARING EQUIPPED

These mills are built in all sizes and roller-bearing equipped throughout.

Full details on request.

BLISS for MACHINERY

E. W. BLISS CO., BROOKLYN, N. Y., U. S. A.

Factories: BROOKLYN, N. Y. HASTINGS, MICH. SALEM, OHIO

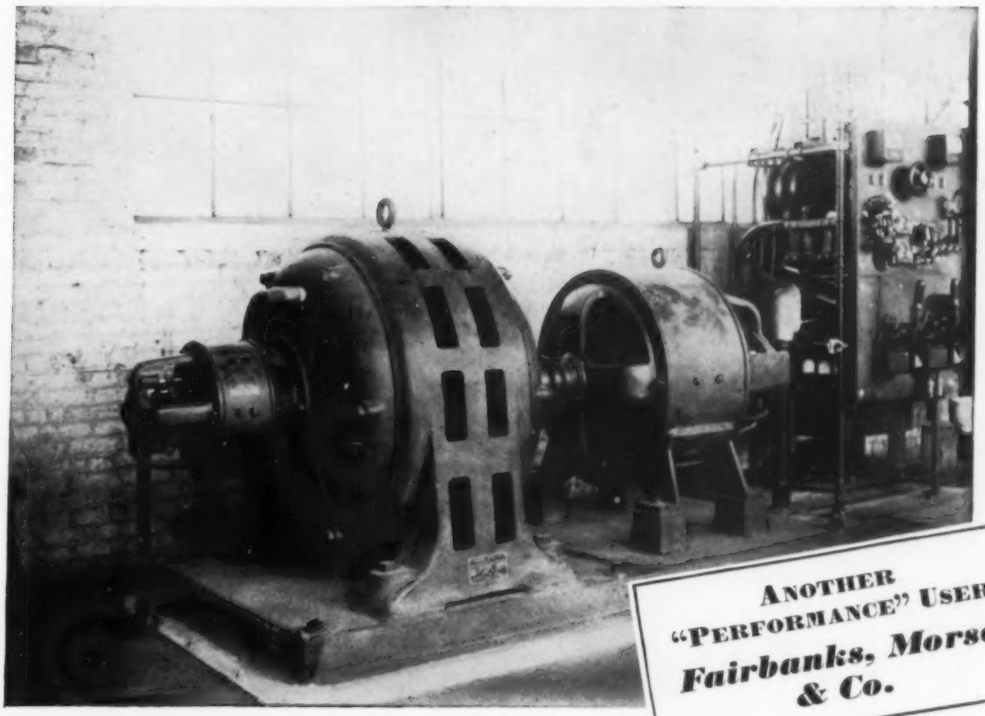
Sales Offices: DETROIT CLEVELAND CHICAGO ROCHESTER PHILADELPHIA DAYTON NEW HAVEN BOSTON

Foreign Factories and Offices: LONDON, Eng. TURIN, Italy PARIS, France

BLISS

No. 578

LOWEST COST CERTAIN FROM SKF'S PER BEARING HOUR!



ANOTHER "PERFORMANCE" USER
Fairbanks, Morse & Co.

WHERE PERFORMANCE TAKES PREFERENCE OVER PRICE

Five SKF Self-Aligning Ball Bearings do an important job on this 150 H. P.-100 K. W. F-M synchronous motor set used to raise the power factor in a large steel plant. For this piece of electrical equipment as well as other types of motors throughout a steel mill, dependability is imperative. There is no mystery as to why SKF Performance Takes Preference Over Price.

Reliability and SKF Bearings have become a synonymous thought where electric motors are considered for exacting service. The reasons are obvious... SKF's insure smooth operation, require no adjustments and eliminate the breakdowns generally caused by bearing difficulties. And it is not unusual to expect... and get...a standand of efficiency which makes SKF *Performance lowest in cost per bearing hour.*

● *You may buy a bearing as a bargain but try and get a bargain out of using it, for nothing is apt to cost so much as a bearing that cost so little.*

2800

SKF INDUSTRIES, INC. 40 EAST 34th STREET, NEW YORK, N. Y.

SKF
Ball and Roller Bearings

Safety – For Old Cranes For New Cranes – Safety
LINTERN ELECTRO MAGNETIC SANDER
PATENTED NO.
220-250 V. D. C.
THE NICHOLS-LINTERN CO.
CLEVELAND, OHIO, U. S. A.
N-L

Do away with the old-fashioned, dangerous method of sanding crane rails by hand, on old as well as new cranes. Sand is an absolute necessity for safe efficient operation, when crane wheels are greasy, icy or wet. Reliable, inexpensive, the Lintern Electro-Magnetic Sander protects your men from the hazardous job of riding the end carriage with a bucket of sand.

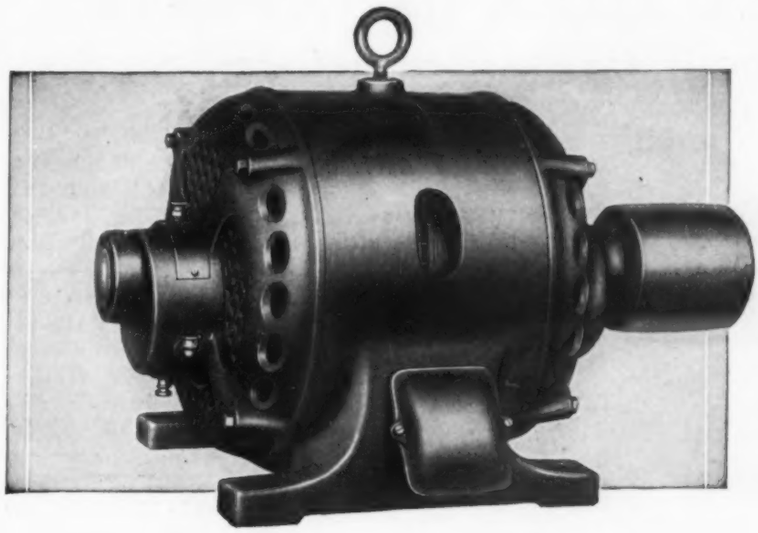
THE NICHOLS-LINTERN COMPANY + + CLEVELAND, OHIO

CANADIAN REPRESENTATIVE:

RAILWAY & POWER ENGINEERING CORPORATION, LTD.

Montreal Toronto Winnipeg Vancouver

THEY KEEP A-RUNNING



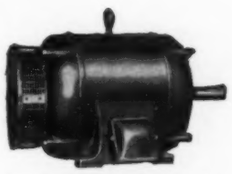
10 Horse Power Century Type SCN Across-the-line Start Squirrel Cage Induction 3 Phase, 60 Cycle, Motor.

Easy to Install and Control—

No current-limiting starting equipment is required in connection with Century Type SCN Squirrel Cage Motors in 30 horse power and smaller sizes. They may be thrown directly across-the-line because their starting current is within NELA recommendations. This simplifies installation and operation and reduces both initial and maintenance costs . . . No current is dissipated in starting equipment—the motor takes full advantage of the line current.

Because the starting torque of these motors is practically the same as that of standard type SC Single Squirrel Cage Motors, they are especially suited for all general purpose applications where normal starting torque is satisfactory and where simplicity of starting equipment is desirable.

Century Polyphase Motors are built in standard sizes from ¼ to 250 h. p.



Totally-Enclosed Fan-Cooled Motor. Built in standard sizes from 1½ to 150 horse power.

CENTURY ELECTRIC COMPANY
1806 PINE ST. • • ST. LOUIS, MO.
40 U. S. and Canadian Stock Points and More Than 75 Outside Thereof

SINGLE PHASE, THREE PHASE, AND DIRECT CURRENT MOTORS

Century MOTORS

MOTOR GENERATOR SETS, ROTARY CONVERTERS, FANS AND VENTILATORS

FOR MORE THAN 27 YEARS AT ST. LOUIS

FARREL-SYKES GEARS ARE APPLICABLE IN EVERY FIELD OF INDUSTRY — *Wherever*

power is transmitted between parallel axes

The design of gear teeth has occupied our attention for about twenty years and we believe that the continuous tooth herringbone gear, which embodies the results of our research, is the best to use for parallel axes.

The teeth are herringbone form with the contours true involute, ensuring uniform angular velocity: the helix angle is 30°, proved best for all general conditions; there are no end thrust problems so that simplicity of design is assured, and the continuous form of teeth have the maximum bearing surface and strength.

GEARS UP TO 20′ DIA. 27″ FACE, 24 D. P. to .75 D. P. AND UP TO 120″ DIA. 54″ FACE

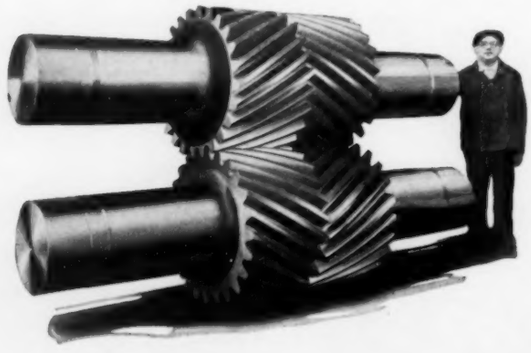
MILL PINIONS UP TO 54 FACE .75 D. P. IN CAST STEEL, FORGED STEEL OR ALLOY STEEL NORMALIZED OR HARDENED AND TEMPERED

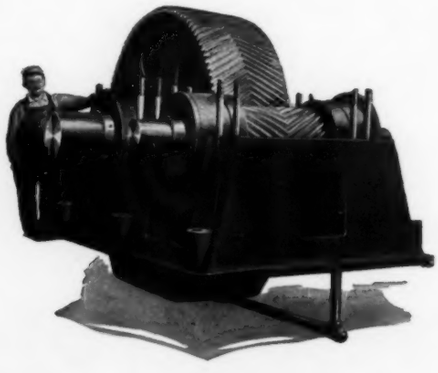
REDUCING OR INCREASING SPEED UNITS TO TRANSMIT UP TO 10,000 H. P. AT ANY PRACTICAL SPEED

TWO-SPEED DRIVES AND SPECIAL ENGINEERING WORK OF ALL DESCRIPTIONS

LEVELLER PINIONS SMALL ENCLOSED UNITS FOR CONVEYOR DRIVES DRAWBENCH DRIVES, ETC.

Take advantage of our Engineering Service. We may have solved your Particular Problem.





FARREL-BIRMINGHAM CO., Inc.

SUCCESSOR TO
FARREL FOUNDRY & MACHINE CO., ANSONIA, CONN., AND
BUFFALO, N. Y., AND BIRMINGHAM IRON FOUNDRY OF DERBY, CONN.
ADDRESS REPLIES TO THIS ADVERTISEMENT TO BUFFALO PLANT
366 VULCAN ST., BUFFALO, N. Y.

BRISTOL *announces the...*

Recording Absolute Pressure Gauge

which accurately records pressures above the absolute zero

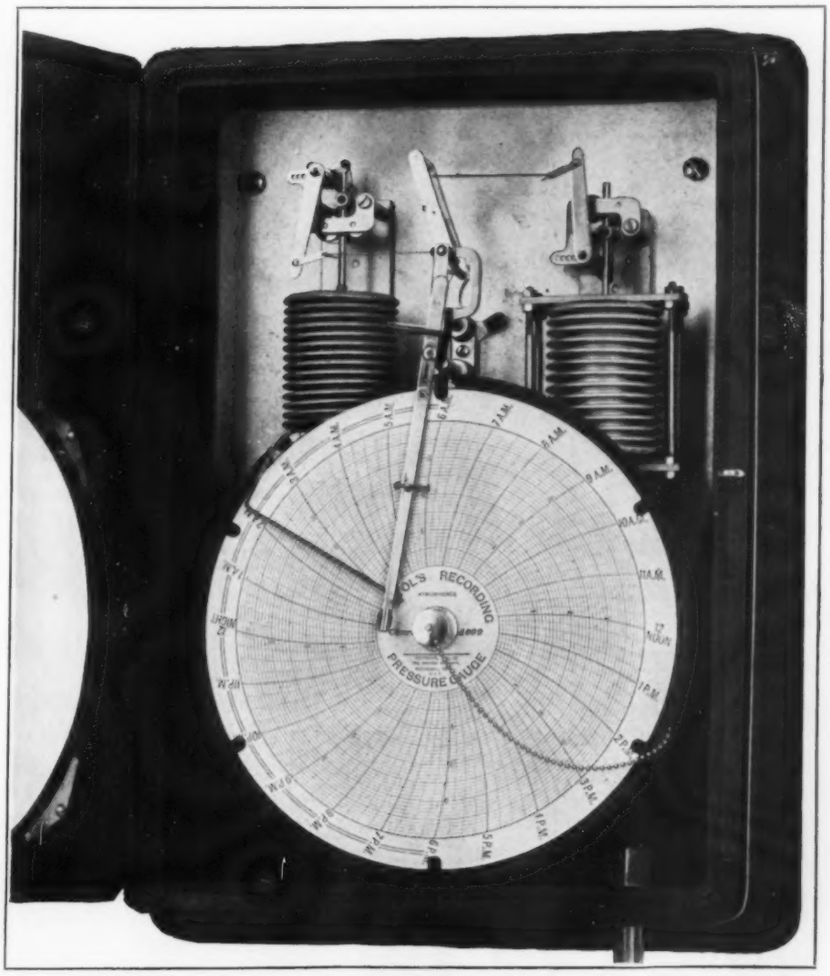
OFTEN where a vacuum gauge is used the measurement really desired is not vacuum but absolute pressure.

Before the development of BRISTOL'S Recording Absolute Pressure Gauge, absolute pressure generally was computed by subtracting from the barometric pressure the vacuum which the gauge indicated. Two observations, barometric pressure and vacuum, were always needed before absolute pressure itself could be determined.

Now BRISTOL presents to industry a new Recording Absolute Pressure Gauge that gives an accurate continuous 24 hour record of absolute pressure, automatically compensated for barometer fluctuations.

This remarkable recorder possesses these four features:

DIFFERENTIAL LINKAGE:
This is essentially a cross member, pivoted at the middle to a rigid extension of the pen arm, and connected at the ends to the two sensitive actuating elements. It swings freely. It correlates the motions of the two sensitive elements, and communicates to the recording pen arm the differential motion which is directly proportional to the absolute pressure.



TWO SENSITIVE ACTUATING ELEMENTS:
Both the barometer element which is hermetically sealed and the element which is connected to the vacuum are extremely sensitive to the slightest variations in pressure. These elements respond to fluctuations by expanding or contracting with a linear movement. The motions are transmitted by a suitable linkage to the pen arm.

PEN ARM AND CHART:
The chart is accurate throughout its entire range. Graduations are in tenths of an inch of mercury column. Readings can easily be estimated to hundredths.

CLOCK:
The spring motor clock rotates the chart. It synchronizes the record with the time of day. It provides a continuous record of absolute pressure, and also reveals the exact time and duration of any and all fluctuations.

Precision measurement of absolute pressure is of great importance to industry. In the manufacture of products ranging from electric lamps to perfume, in petroleum refineries, steam turbine plants, in food packaging processes, in fact wherever operations are carried out under a vacuum, the value of recording absolute pressure accurately cannot be overemphasized.

You will want further information about this new achievement in precision pressure measurement. We shall gladly send you facts and figures. Just fill in and return the handy coupon.

THE BRISTOL COMPANY
WATERBURY CONNECTICUT

Branch Offices: Akron, Birmingham, Boston, Chicago, Denver, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFF.

INSTRUMENTS FOR INDICATING RECORDING CONTROLLING SINCE 1889

THE BRISTOL COMPANY
Waterbury, Conn. I.S.E.—12-31

Please send information on BRISTOL'S Recording Absolute Pressure Gauge to:

*Name*_____

*Address*_____

SAVE TIME AND EXPENSE WITH JEFFERSON UNION RENEWABLE FUSES

ONE —
UNSCREW ONE-PIECE END CAPS

TWO —
INSERT NEW LINK

THREE —
SCREW ON ONE-PIECE END CAPS

AND THE FUSE IS RENEWED!

Why Jefferson-Union Ferrule Fuses Save Time and Money

The Jefferson-Union Ferrule Type Fuses have end-caps in one piece, without loose washers or end plugs, assuring positive contacts with fuse clips. Venting is through the caps, not the threads. Inspection and cleaning are easy, convenient. So is insertion of fusible link which adjusts itself automatically in length for a perfect fit. Held diagonally in the casing, it does not touch or char the casing. These features assure long life, low cost, quicker renewals.

Another time and cost saver—Jefferson-Union Knife-blade Renewable Fuse

The Jefferson-Union Knife-blade Fuse is uniquely simple. Insertion of a new link is a matter of seconds. Only one end-cap is removed. Loosening the studs a little permits speedy insertion of link. Rugged construction plus an exclusive method of venting through the fibre insures long-continued life.

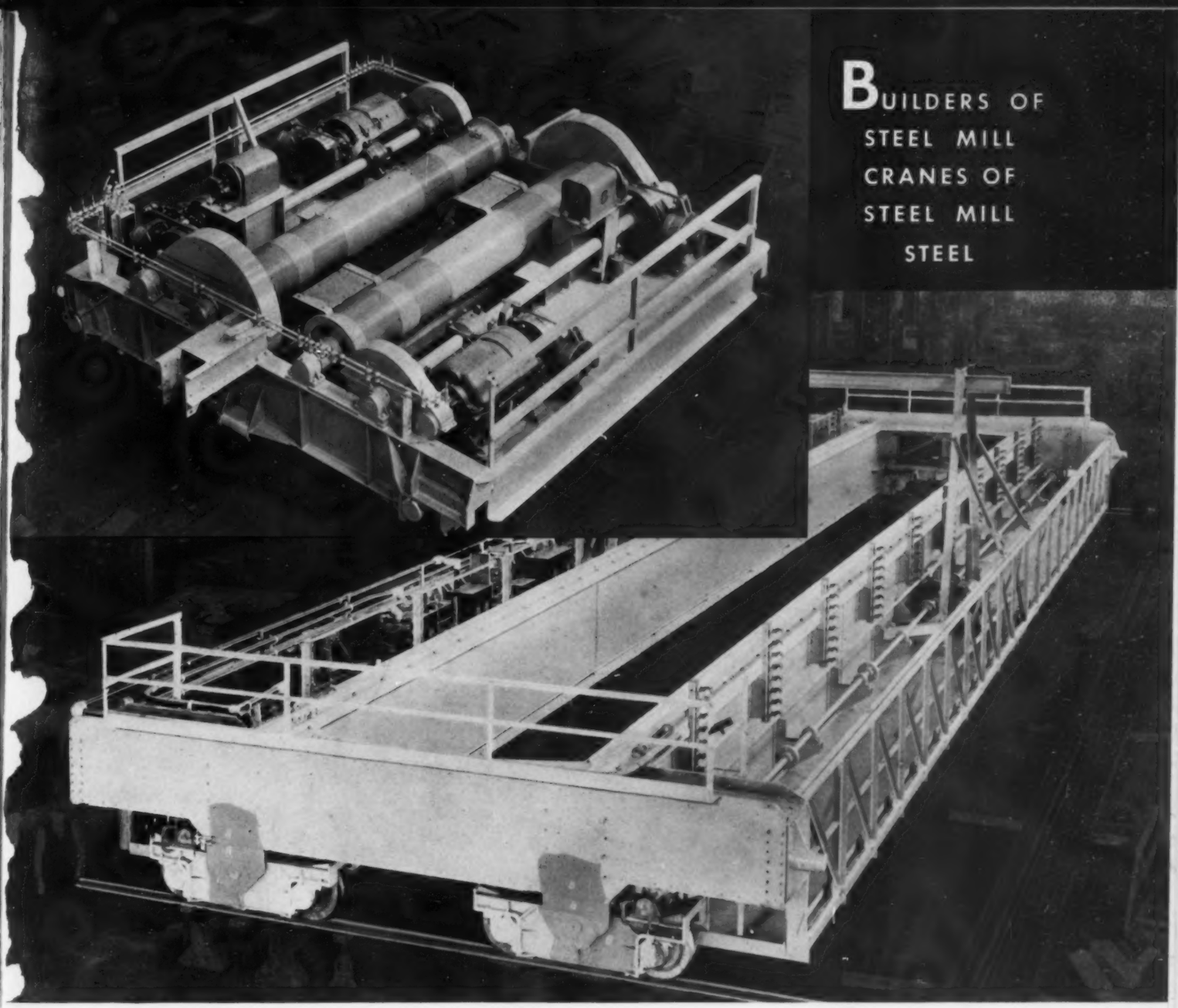
YOU'LL get little advance notice when prosperity comes back. Use these days then to get equipment ready . . . don't be caught napping.

Particularly prepare on such essential yet small-expense items as fuses. Check up every motor and electric circuit, see that fuses are replaced . . . *and replaced with Jefferson-Union Renewable Fuses.*

Jefferson-Union Fuses withstand blowout after blowout . . . and the fusible links are replaced in a few seconds. They cut yearly fuse costs and loss of productive time among men, motors and machines.

Getting these small items off the list simplifies your whole maintenance problem . . . and it is real economy to lay in a supply now.

JEFFERSON ELECTRIC COMPANY
1517 West 15th Street Chicago, Illinois
A-4900



BUILDERS OF STEEL MILL CRANES OF STEEL MILL STEEL

THIS 15-ton, 100-ft. span Cleveland crane is equipped with roller bearings throughout. They are lubricated by a pressure system operated from a convenient location on the crane. One of two cranes built for a large tube mill.

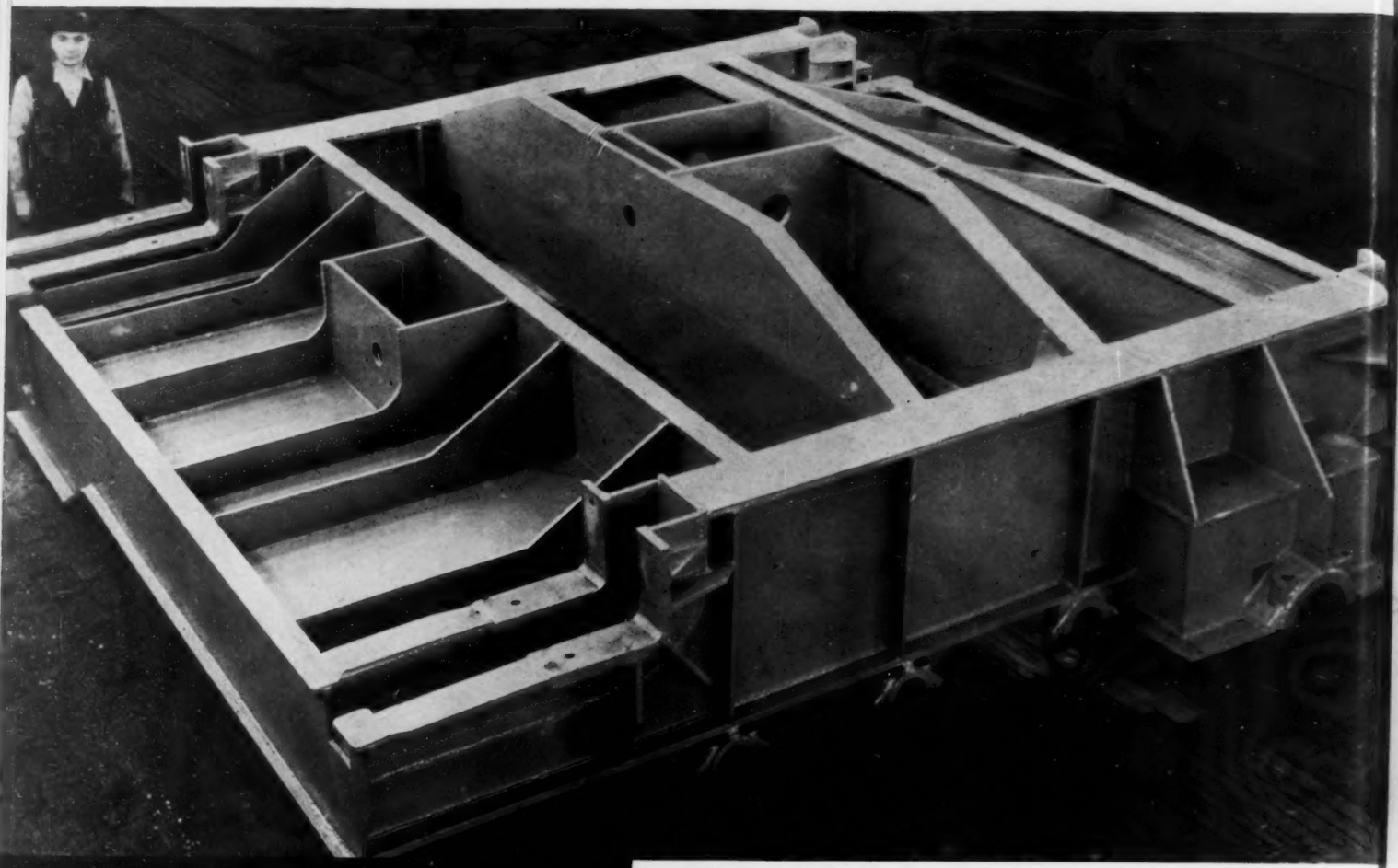
THE CLEVELAND CRANE & ENGINEERING COMPANY, WICKLIFFE, OHIO

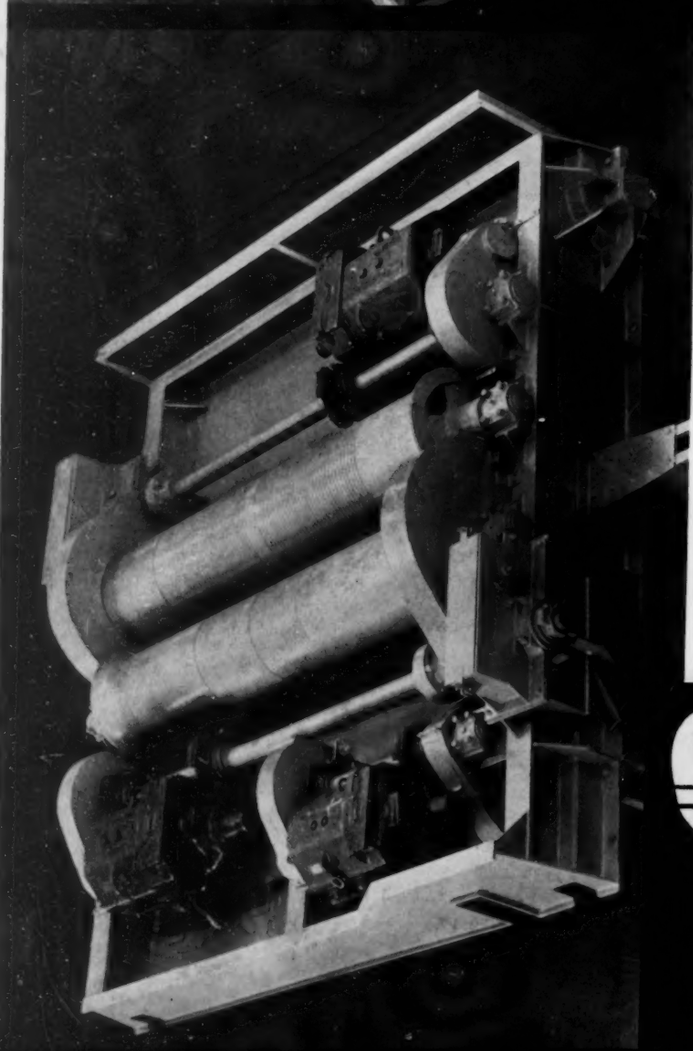
NEW YORK PITTSBURGH DETROIT CHICAGO

CLEVELAND CRANES

All Sizes for Every Service

■ BUILDERS OF STEEL MILL CRANES OF STEEL MILL STEEL ■





THIS trolley frame for a 50-ton, 15-ton auxiliary, 62-ft. span steel mill crane is built of steel mill steel. Note the welded design . . . the result of Cleveland Crane's years of experience in building steel mill cranes of one-piece welded rolled steel construction. Cleveland Crane has built more than 500 crane units of welded construction.

THE CLEVELAND CRANE & ENGINEERING COMPANY

WICKLIFFE, OHIO

NEW YORK • PITTSBURGH • DETROIT • CHICAGO

CLEVELAND CRANES

All Sizes for Every Service

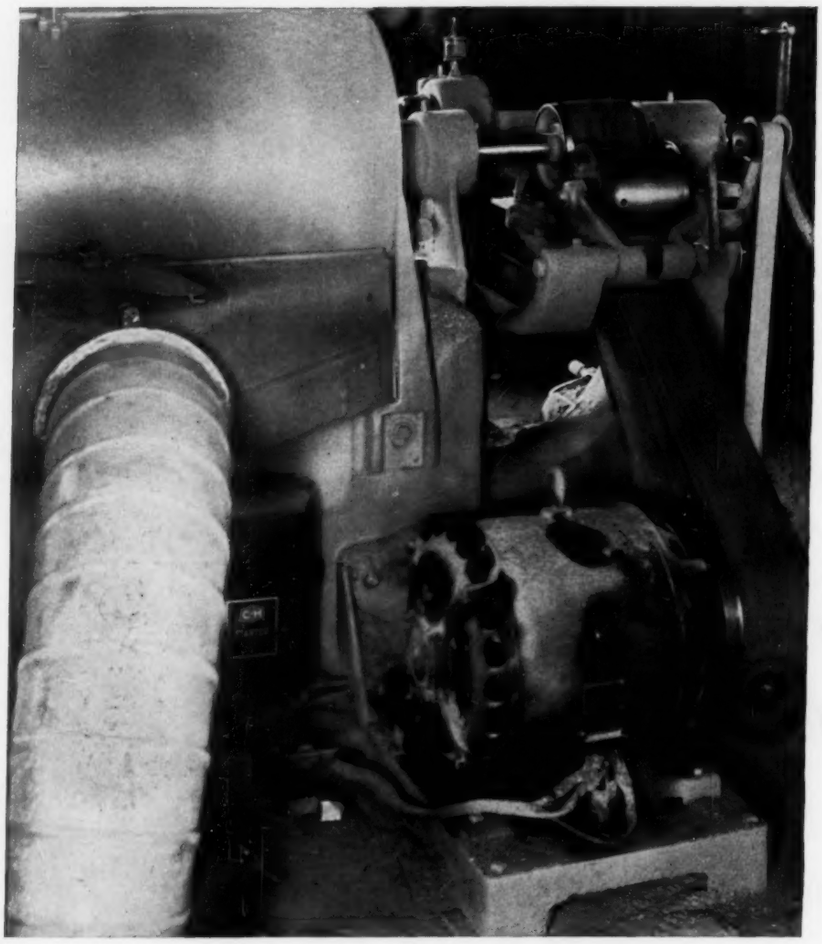
This two-motored Baker Tractor is one of eight types ranging in size from 1000 to 6000 pounds draw-bar pull, each designed for specific applications.

BAKER CUTS TIME 75%

With a Baker Tractor and one operator, a Chicago car shop is handling cars in one-fourth the time formerly required. • • • The Baker pushes 50-ton cars into the spray-painting booths, handling this tremendous weight up a ramp which rises 9 inches in 9 feet. • • • Thousands of other Baker Tractors, Trucks, and Cranes are performing other tasks just as efficiently, in practically every industry. May we tell you how they are saving money for others in *your* line?

BAKER INDUSTRIAL TRUCK DIVISION
of THE BAKER-RAULANG COMPANY • 2166 West 25th St., Cleveland, Ohio
Sales Offices in all principal cities
Canadian Representative: The Railway and Power Engineering Corporation, Ltd.,
Offices in Toronto, Montreal, Winnipeg, Vancouver

ELECTRIC TRACTORS AND TRUCKS
TRADE-MARK REG. U.S. PAT. OFF
Baker



Motor bearings that don't leak

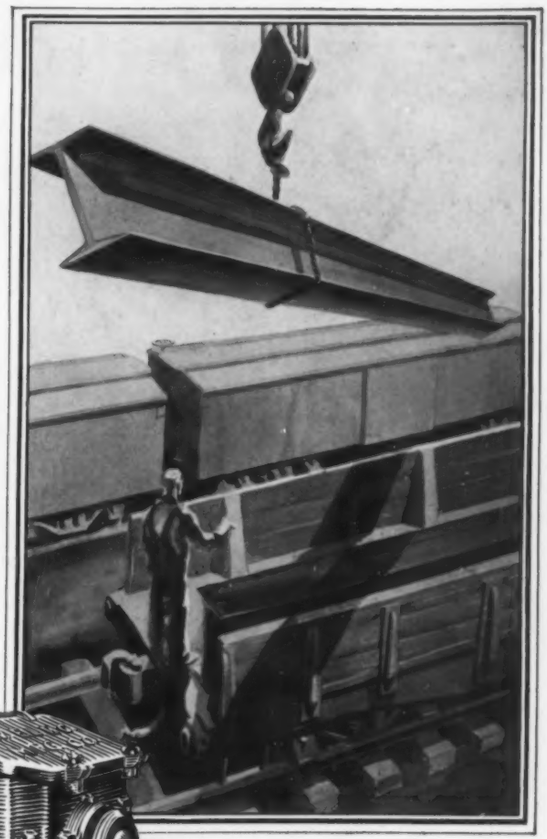
Unless kept in its proper place, lubricant is a fire hazard and a spoiler of materials . . . in the carpenter shop and many other places. Motors equipped with New Departure Ball Bearings are leak-proof . . . good seals take care of that and protect the bearings from dust and dirt. Consider, too, the thrust capacity of New Departures which permits vertical as well as horizontal mountings. And the fact that lubrication, with them, is but a yearly task. It surely is an easy way to save money

1807

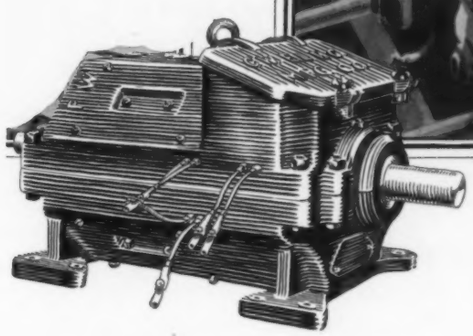
NEW DEPARTURE BALL BEARINGS

. . . just specify New Departures. The New Departure Mfg. Co., Bristol, Connecticut; Detroit, Chicago, San Francisco, London.

The illustration shows a Century Motor in a wood working shop. Its bearings are New Departures.



How many motors—



. . . to make an I-beam?

Count 'em . . . .
And the failure of any of them would as efficiently stop steel making as the lack of ore or orders.
No other industry is more dependent upon the uninterrupted functioning of its motors in each successive step of production, as is the manufacture of Iron and Steel. Yet no other industry abuses its motors more.

It is a tribute, then, that for 25 years Crocker-Wheeler has been the leader in supplying motors for the Steel Mill. This demand was not gained by high pressure sales work . . . or by price cutting . . . but by building into each and every motor all that was necessary to produce uninterrupted motor service under all conditions . . . and by charging a fair price for a good product.

Crocker-Wheeler Electric Mfg. Co.

AMPERE, NEW JERSEY

Birmingham Boston Buffalo Chicago Cleveland Cincinnati Detroit
Houston New York Philadelphia Pittsburgh San Francisco Seattle

CROCKER WHEELER

He had 6 MEN ON THE PAYROLL

BUT ONLY 3 OF THEM WORKED

TRUE, he passed out only three actual pay checks. Yet he paid double for every payroll hour. Benumbing cold is a payroll factor in many HARD-TO-HEAT places. When heat goes down—payroll goes up.

When there's important work to do it's not smart to be thrifty with heat. When pumps are overburdened and liquids are sluggish what about the cost of extra power? When men can't work and production drags, what about your increased cost per unit? A few cents per hour for a Chromalox Electric Air Heater may save several dollars per hour in production costs.

Tell us your heating problems so we can help you. Don't try to extend costly pipe lines. Don't risk open flame. Don't decide on any other heating until you've tried Chromalox. You owe it to yourself to get the facts about these easily installed electric heaters that are fast supplanting old methods. Check those cold spots in your plant—and mail the coupon today.

Chromalox Electric Air Heaters Manufactured Exclusively By

EDWIN L. WIEGAND COMPANY

7545 THOMAS BLVD. PITTSBURGH, PA.

CHROMALOX ELECTRIC AIR HEATERS

This Bulletin C-108—"For Heating Hard-to-heat Places" shows complete line of Chromalox Electric Air Heaters—dozens of sizes and ratings, 250 watts to 6 Kw. 115, 230, 250, 440 or 550 volts.

Also gives useful data about how to properly mount heaters, use of automatic control, etc. —plus many actual installation photographs.

Mail this coupon with your letterhead

To EDWIN L. WIEGAND CO., 7545 Thomas Blvd., Pittsburgh, Pa.
We want to heat the following hard-to-heat places in our plant:

Ft. Long..... Ft. Wide..... Ft. High..... Used for.....

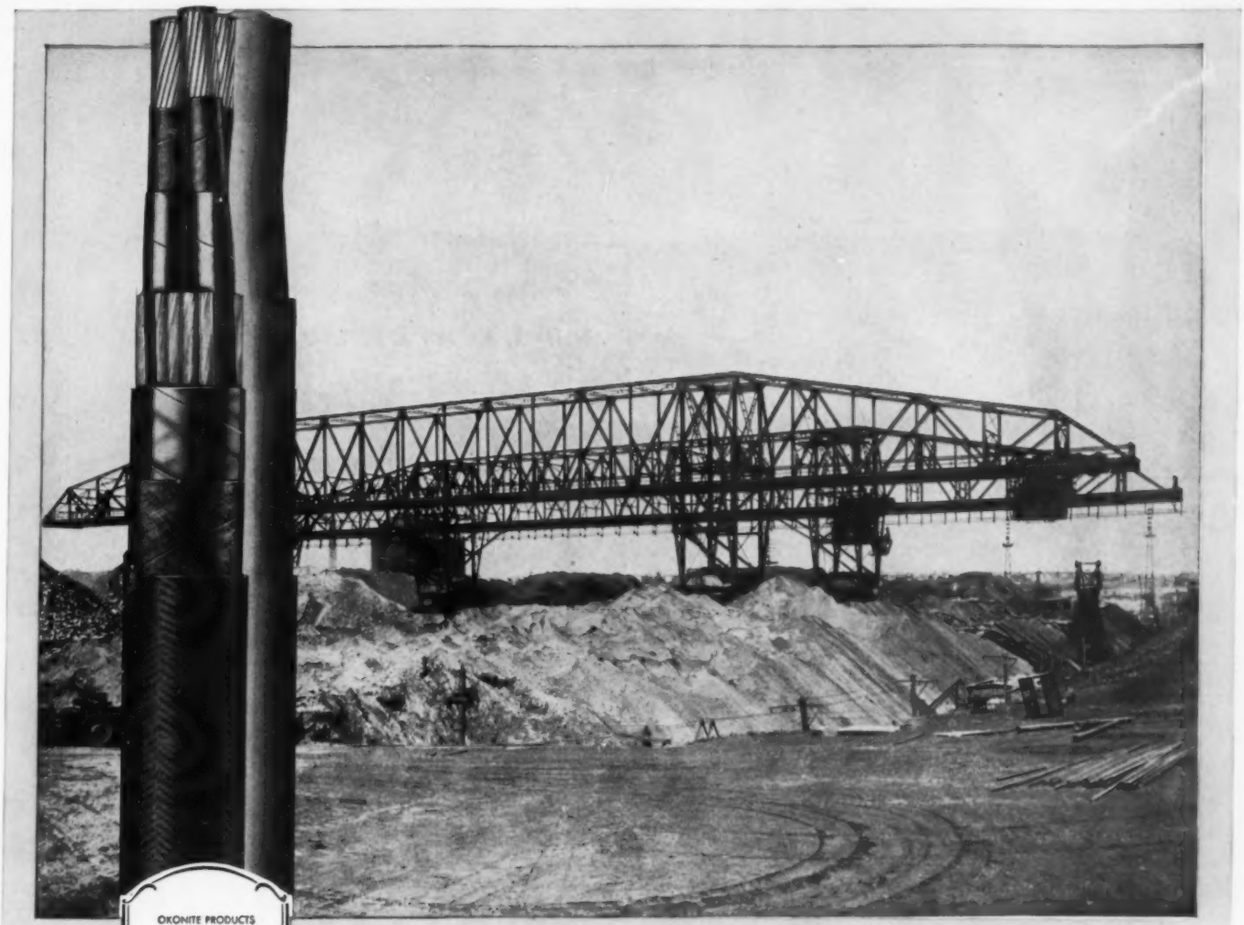
Ft. Long..... Ft. Wide..... Ft. High..... Used for.....

Ft. Long..... Ft. Wide..... Ft. High..... Used for.....

Please send us complete information about the size and type of heaters to properly fill our requirements. Also send us without obligation, your bulletin C-108 entitled—"For heating hard-to-heat places."

Signed..... Position.....

Address.....



OKONITE PRODUCTS

Okonite Insulated Wires and Cables

Varnished Cambric Cables

Okonite Insulating Tape

Manson & Dundee Friction Tapes

Okocord

Okoloom

OKONITE-CALLENDER PRODUCTS

Impregnated Paper Cables

Super-tension Cables

Splicing Materials

Okonite Versatility

NO matter what conditions govern the selection of electrical cables, there is a type and size that best meets each demand. OKONITE rubber and varnished cambric insulation, OKONITE-CALLENDER impregnated paper insulation can be combined with any conceivable arrangement of protective covering to make exactly the correct construction for your work.

THE OKONITE COMPANY

Founded 1878

THE OKONITE-CALLENDER CABLE COMPANY, INC.

Factories: Passaic, N. J. Paterson, N. J.

SALES OFFICES:

NEW YORK CHICAGO PHILADELPHIA PITTSBURGH ST. LOUIS BOSTON

ATLANTA SAN FRANCISCO LOS ANGELES SEATTLE DALLAS

Novelty Electric Co., Philadelphia, Pa.
F. D. Lawrence Electric Co., Cincinnati, O.

Canadian Representatives:
Engineering Materials, Limited, Montreal

Cuban Representatives:
Victor G. Mendoza Co., Havana

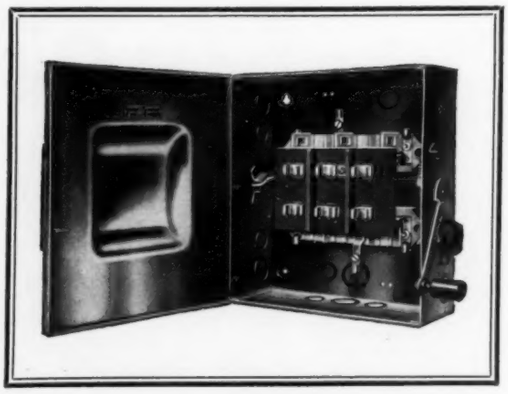
OKONITE QUALITY CANNOT BE WRITTEN INTO A SPECIFICATION

Dependability . . . .

The most dependable weapon of the Roman Legion was the two edged broadsword. This had no front or back so whichever edge was handiest could be used.

Equally dependable and convenient is the new Colt-Noark Quadbreak Switch. Since the current is ruptured four times in each leg of the circuit the fuses are dead on both ends when the switch is "off". The line wires may therefore be brought to either top or bottom.

How many times have you wished you could do that?



Completely described in Catalog "L". May we send you a copy?

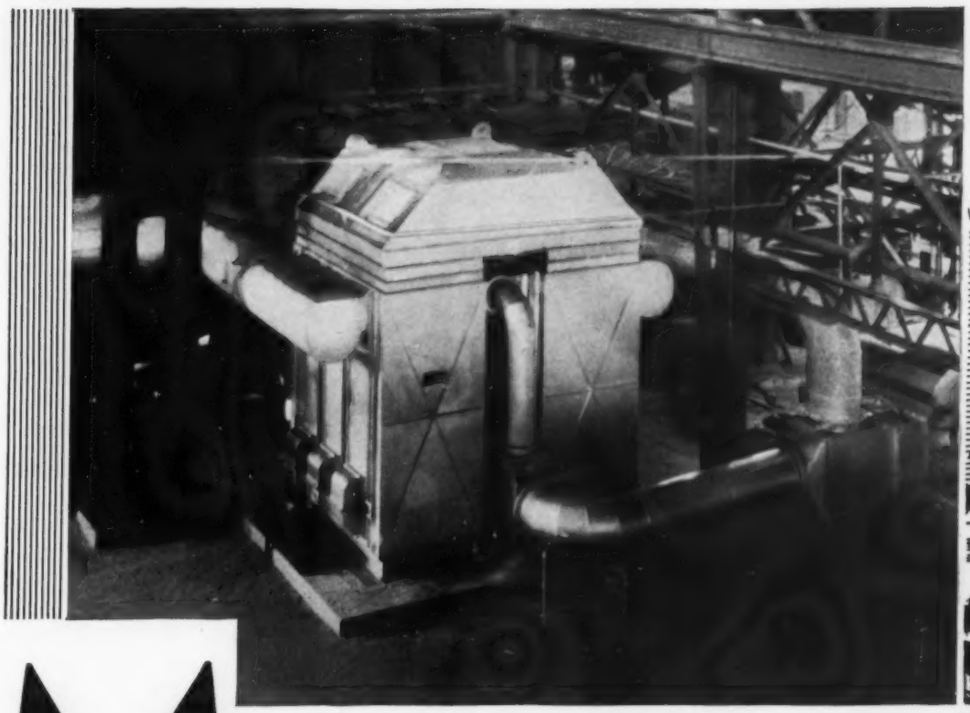
COLT'S PATENT FIRE ARMS MFG. CO.

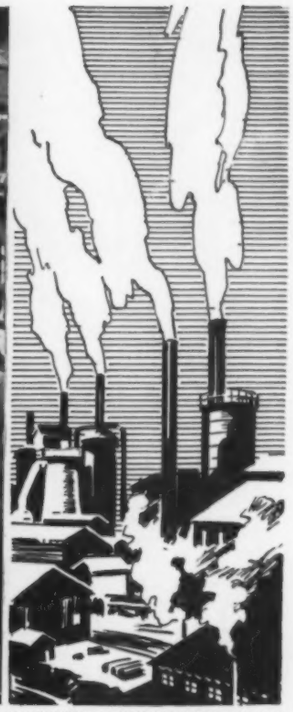
PIONEERS OF PROTECTION SINCE 1836

ELECTRICAL DIVISION HARTFORD, CONN., U. S. A.

BOSTON CHICAGO NEW YORK PHILADELPHIA SAN FRANCISCO

M-10-31





MANTLE RECUPERATORS

. . . . . FOR LONG SERVICE UNDER SEVERE CONDITIONS

Many features of MANTLE Recuperators make for long life and low maintenance costs. The alloy used in the construction of the elements and other parts contacting the flue gases is especially selected for this service. All elements are so fabricated that all welds are positioned into the air passages. All joints, therefore, are adequately air-cooled and shielded from any possible detrimental influence of the flue gases. The design of MANTLE Recuperators is such that the elements are relieved from undue stress or strain from expansion under heat.

You will want the Mantle Recuperator Catalog. *Request it right away..without obligation.*

OPERATED BY HENRY L. DOHERTY & COMPANY

Surface Combustion

SURFACE COMBUSTION CORPORATION
TOLEDO, OHIO.

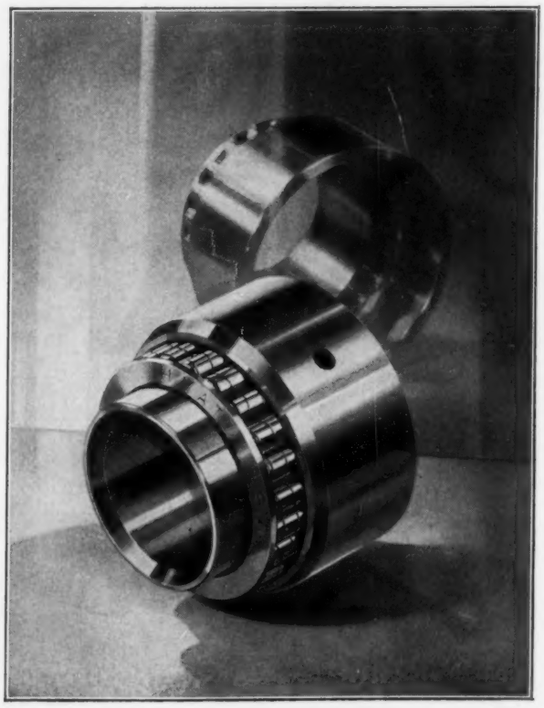
SALES AND ENGINEERING SERVICE
IN PRINCIPAL CITIES

Equipped for Economy

The use of Hyatt Roller Bearings is an assurance of longer equipment life...a guarantee of dependable, economical bearing operation.

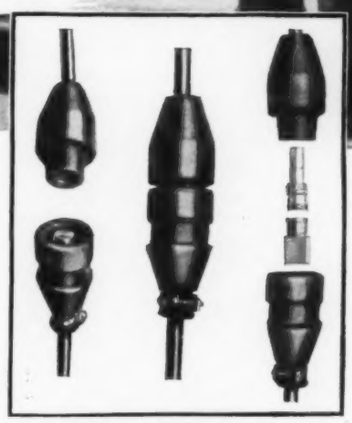
Wear and tear of friction is eliminated; power is saved; maintenance is reduced to only an occasional lubrication. Year after year they perform flawlessly and roll up profits. For Hyatt Bearings are very easy on expenses.

Investigate the design and operation of Hyatts. Judge the efficiency of these better bearings. Consider what they will mean to the equipment you build or purchase. Hyatt Roller Bearing Company, Newark, Detroit, Chicago, Pittsburgh, Oakland.

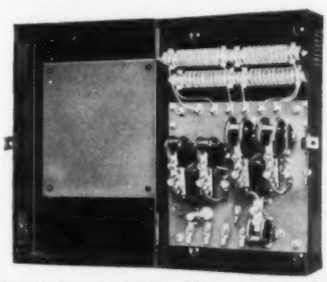


HYATT
ROLLER BEARINGS
PRODUCT OF GENERAL MOTORS

Strongest of all animals, elephants sometimes live hundreds of years.



Another C-H Innovation
—the Lifting Magnet Cable Connector
Weatherproof, strain-resisting, the C-H Cable Connector provides the means to detach magnet from cable quickly. This self-locking device attaches or detaches simply by screwing or unscrewing.



C-H Automatic Lifting Magnet Controller
Greater Lifting Capacity—Speedier Operation

BRUTES
FOR LIFTING POWER
. . . LONGEST-LIVED

BIG-BODIED BRUTES...solid as a rock throughout...C-H Magnets are built to *lift*—and to *last*—the "elephant" among magnets. The case is crammed with wound strap-copper, most compact of *all* coil material, affording the utmost lift per cubic inch.

The coil is embedded in an exclusive impregnating compound which won't crystallize, can't burn, never permits the coil to shift, keeps out moisture, and forever prevents a short circuit.

Maintenance tells the tale where magnets are concerned. No C-H Magnet has ever come back to the factory for pole-shoe breakage; there are C-H magnets on record with 15, 20 years of steady, unbroken service. And now the patented new automatic lifting controller gives speedier lift and drop than ever before.

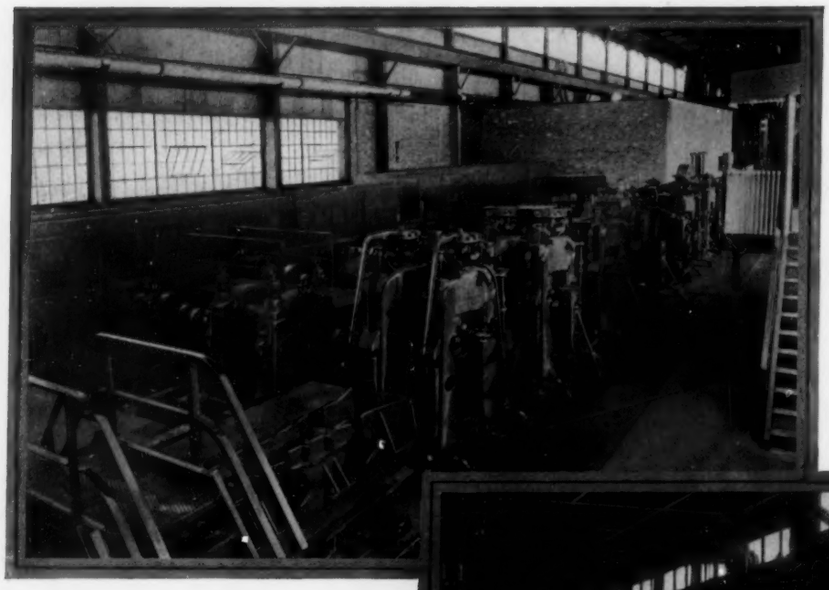
Your *next* magnet should be a C-H. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* 1257 St. Paul Avenue, Milwaukee, Wisconsin.

CUTLER HAMMER

Red Top Heavy Duty Lifting Magnets

MORGAN ENGINEERING MEANS MILL EFFICIENCY

MORGAN • CONTINUOUS • MILLS



MORGAN 19″ 6-STAND CONTINUOUS BAR *and* BILLET MILL

Designed and built complete for the Continental Steel Corporation, Kokomo, Indiana

Among various products which can be rolled on this mill are 12″ sheet bar and 1¾″ square billets.

24″ 4-STAND CONTINUOUS ROUGHING MILL *for* AXLE PLANT

•

THIS installation was built complete, including four stands with bevel gear drive, Approach and Runout Tables with switches and pockets for serving six Morgan 7500 lb. Axle Forging Hammers.

Write for Bulletin No. 16

THE MORGAN ENGINEERING COMPANY

NEW YORK 25 BROADWAY

ALLIANCE, OHIO, U.S.A.

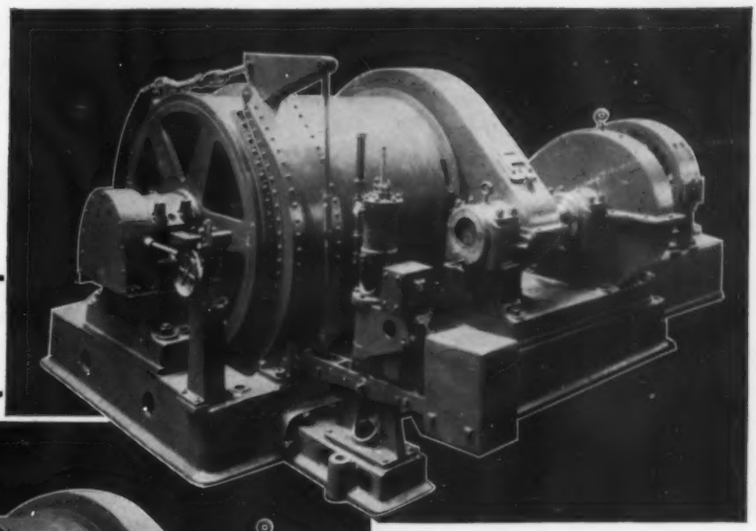
PITTSBURGH 1420 OLIVER BLDG.

MORGAN DESIGNS AND BUILDS

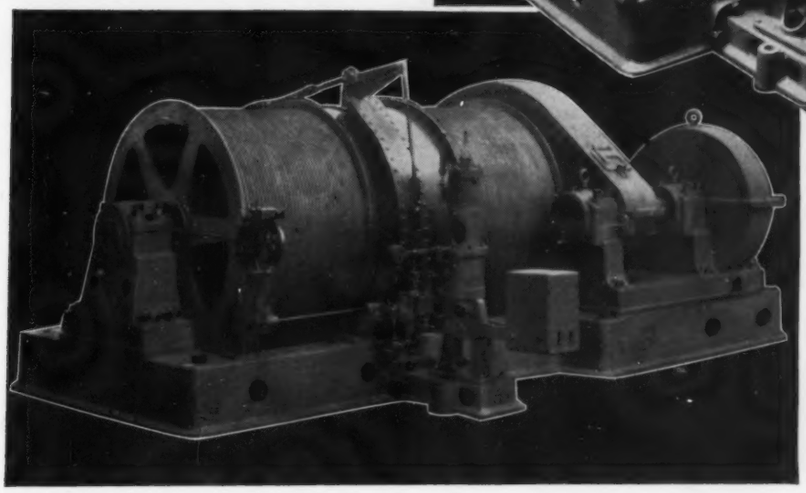
Blooming Mills · Plate Mills
Structural Mills
Continuous Mills
Rod and Bar Mills

Electric Traveling Cranes
Steam Hydraulic Forging Presses
Steam Hammers

DESIGNERS · MANUFACTURERS · CONTRACTORS



WELLMAN



BLAST FURNACE SKIP

hoists

. . . . NAME your hoisting objective and Wellman engineers will design and build equipment that will accomplish it successfully and economically.

Wellman engineering has produced machinery that has won a name throughout the world.

* * *

WELLMAN PRODUCTS INCLUDE:

Steel and Tube Mill Equipment
Gas Producers, Flues, etc.
Gas Reversing Valves
Car Dumpers, all types
Coal and Ore Handling Equipment
Coke Oven Machinery
Charging Machines and Manipulators
Safety Stops for Traveling Structures
Special Cranes
Mining Machinery
Castings and Machine Work to customers' drawings

THE WELLMAN ENGINEERING CO.

ENGINEERS CONSTRUCTORS MANUFACTURERS

CLEVELAND, OHIO

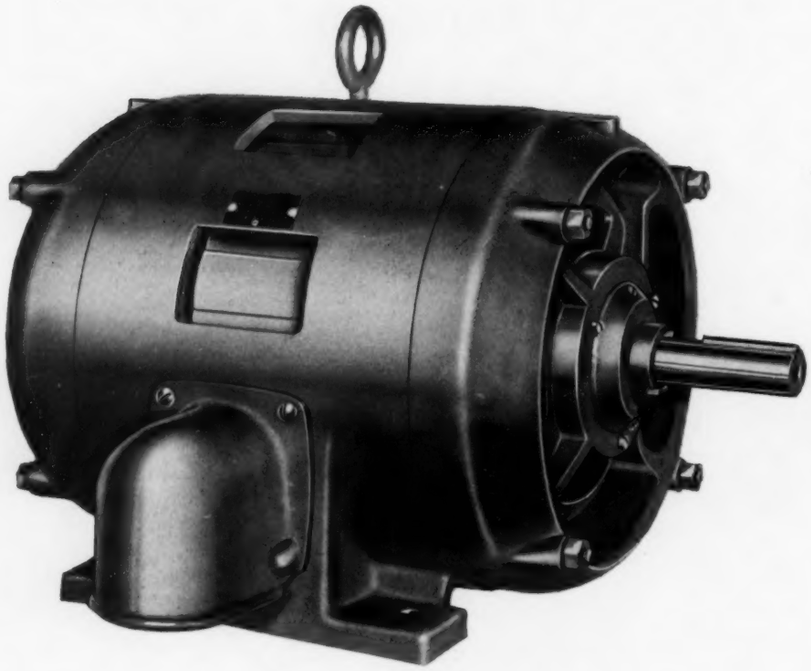
New York City: 30 Church Street
Chicago: Room 401 at 549 West Washington Boulevard
Birmingham: 1101 Webb Crawford Building

Formerly THE WELLMAN-SEAVER-MORGAN CO.

Mexico City: Edificio Oliver, 16 De Septiembre No. 5.
"Canadian Wellman-Seaver-Morgan Co., Limited,"
307 Reford Bldg., Toronto; 821 Castle Bldg., Montreal

MOTORS
GENERATORS

DIRECT & ALTERNATING CURRENT



STURDY
RELIABLE
EFFICIENT

Frames A204 to A505

Standard Dimension-Open-Squirrel Cage Motors

Standard Ratings: ½ H. P. at 900 RPM to 75 H. P. at 1750 RPM

Quality for Half a Century

ELECTRO DYNAMIC COMPANY

BAYONNE — Established 1880 — NEW JERSEY

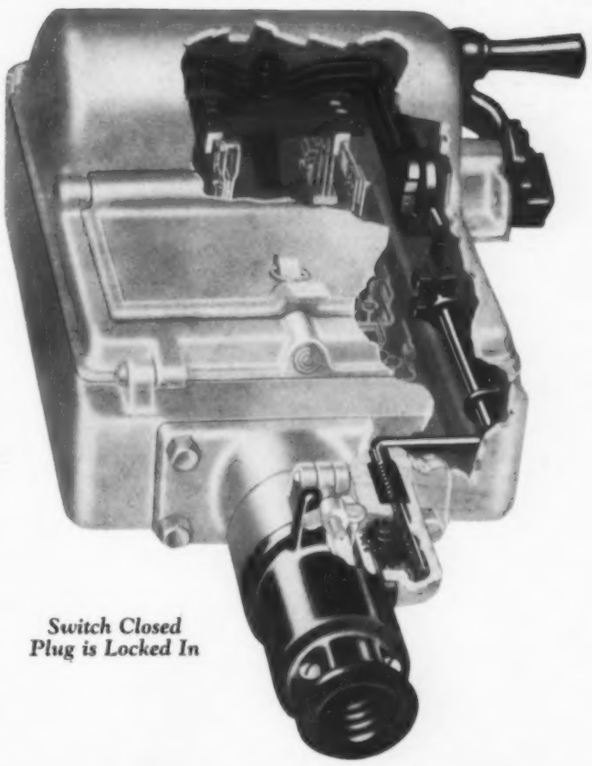
CROUSE-HINDS SAFETY SWITCHES

are 100% Foolproof *and are* DEPENDABLE

It is impossible to withdraw the plug or open the door of the fuse compartment unless the switch is open.

Impossible to close the switch unless the plug is fully inserted and the door of the fuse compartment is closed.

Type MKS interlocking switch and plug are listed in Catalog 2200, which will be sent on request.



Switch Closed
Plug is Locked In

CROUSE-HINDS

ESTABLISHED 1897

SYRACUSE, N. Y., U. S. A.

CANADIAN PLANT: TORONTO, ONT

SALES OFFICES

NEW YORK, BOSTON, PHILADELPHIA, DETROIT, ATLANTA, MILWAUKEE, CHICAGO, ST LOUIS, CLEVELAND, CINCINNATI, MINNEAPOLIS, PITTSBURGH, LOS ANGELES, SAN FRANCISCO, DALLAS, SEATTLE

CH571

Dependable Heavy Duty High Speed Bearings

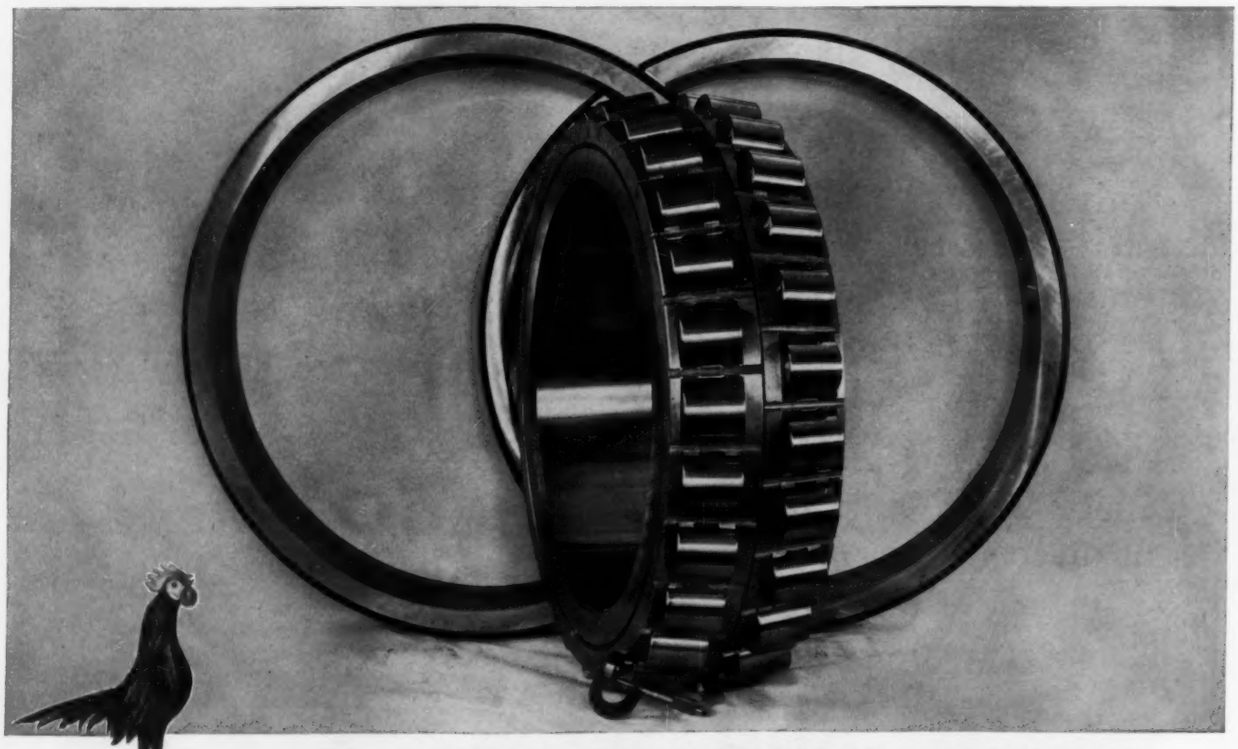
PICTURED BELOW is one of Bantam's tapered roller bearings manufactured for steel mill installations. The outside diameter is 28¾"; inside diameter 18"; width 8". Note the one-piece, lubricating-type, bronze cage. This Bantam design permits the use of more rollers, increases lubricating efficiency and insures rigidity that is unequalled in any other cage.

For 32 years Bantam has pioneered in design and methods for the manufacture of *dependable* bearings. For 32 years Bantam has successfully met every bearing problem submitted. You are invited to submit yours —the tougher, the better.

BANTAM Rollers Do Not Break

Send for the Bantam Ball and Roller Bearing Manual — which includes the first series ever published of standard sizes of bearings for heavy duty service.

BEARING SPECIALISTS FOR 32 YEARS



BBB

Trade Mark Reg.

THE BANTAM BALL BEARING COMPANY

3300 W. Sample St., South Bend, Ind.

NEW YORK CHICAGO PHILADELPHIA INDIANAPOLIS
DETROIT CLEVELAND ST. LOUIS

ONE OR A MILLION • ½" TO 48"

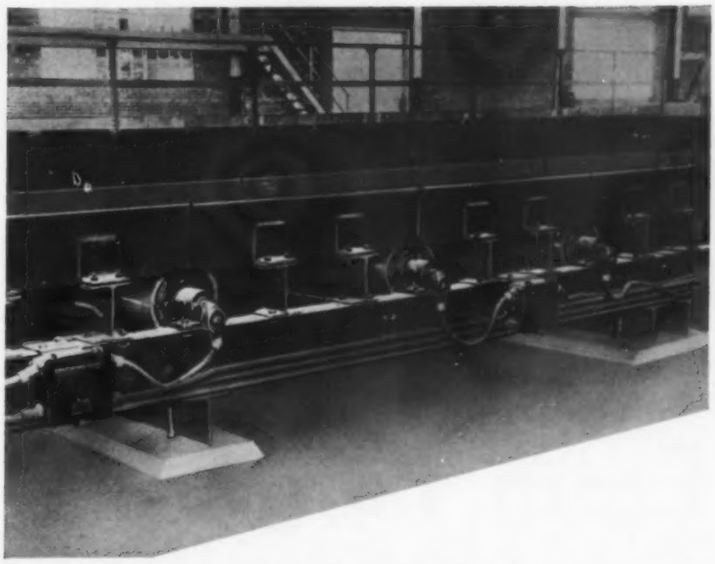
SCHLOEMANN

"MOTOR-ROLLER"

(SCHULTE AND OTHER PATENTS)

SIMPLIFY

construction of your mill-tables by using Motor-Rollers. They are entirely Self-Contained Units, having a stationary shaft and a minimum number of wearing parts, and ensure continuous operation of your tables at low maintenance cost.



MOTOR-ROLLERS are usually connected direct to the line and their rotation is reversed by throwing them across the line; only extremely low and variable table speeds require frequency changers.

We Invite Your Request
For Complete Information

SCHLOEMANN
ENGINEERING COMPANY

Empire Building Pittsburgh, Pa.

Current indicating instruments give instant indication of abnormal conditions in motor-driven units. This control panel for a large ore screening unit has an ammeter in every motor circuit.

From Large Switchboards to Small Control Panels

Jewell provides instruments to exactly meet every need

Not only does Jewell offer a wide range of standard units, but Jewell engineers gladly cooperate in the development of special instruments to meet unusual applications.

Years of specialized experience in instrument design and application—plus the unusually flexible production facilities of the Jewell plant—enable Jewell engineers to provide the most effective solution of any electrical instrument problem.

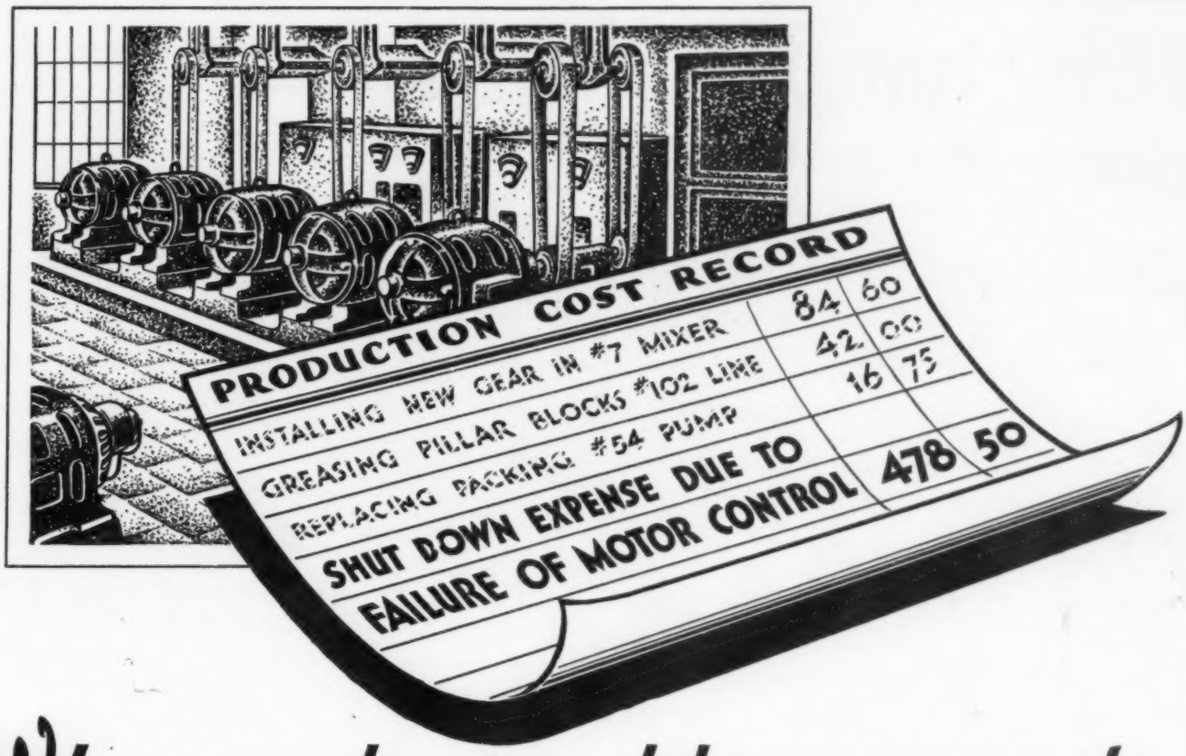
Such problems, submitted direct to the Jewell factory or through Jewell representatives, will have prompt and careful attention.

Jewell Electrical Instrument Company
1650 Walnut Street, Chicago, Illinois

This front of board, 4¾ inch diameter instrument meets every need for motor control panels. Available in A. C., D. C., and high frequency types, with scale ranges suitable for any purpose. Other Jewell switchboard, portable, and miniature instruments are available to meet every need.

31 YEARS MAKING GOOD INSTRUMENTS

JEWELL


PRODUCTION COST RECORD
INSTALLING NEW GEAR IN #7 MIXER 84 60
GREASING PILLAR BLOCKS #102 LINE 42 00
REPLACING PACKING #54 PUMP 16 75
SHUT DOWN EXPENSE DUE TO FAILURE OF MOTOR CONTROL 478 50

Where production delays are costly- install ROWAN *Oil Immersed* CONTROL

ENGINEERS who are responsible for the dependable, uninterrupted operation of machinery have found that costly "shut down" delays are practically eliminated by Rowan Oil Immersed Control.

Weather-proof, dust-tight, vapor-proof — Rowan completely Oil Immersed Control units provide high interrupting capacity and extra insulation between all live parts and a practical elimination of corrosion and mechanical wear by constant lubrication of all moving parts. By quenching all arcs below the surface of the oil, they eliminate the danger of igniting combustible gases in the surrounding atmosphere.

Send today for complete information about the control unit in which you are interested.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

How hot does it get?

(*Socket Heating Report Tells*)

BEFORE the recent changes outlawed rubber wire for fixture work, the National Electrical Code recognized the possibility of trouble in sockets by insisting that specially insulated wires be used in any socket where the temperature exceeded 120°F. (49°C.). They further considered that all sockets holding mogul base lamps attained this temperature—and they surely do.

But many of the smaller lamps reach surprisingly high temperatures—as anyone knows who's burned his fingers removing lamps from sockets.

Just where is the line to be drawn? We've made tests to determine the maximum temperatures reached in sockets holding lamps of relatively low wattages—25, 40, 50, 75 and 100 watts—and have written up the results, complete with graphs, in report form.

This test report will show you why the makers of the Code, realizing the dangerous condition that exists in sockets, changed the specifications of Article 14, Section 1402-d, to require heat resisting wire in all sockets.

A copy of this report will be sent to every interested party. Use the handy coupon.

ROCKBESTOS PRODUCTS CORPORATION
452 NICOLL STREET NEW HAVEN, CONN.

ROCKBESTOS—*the wire with permanent insulation*

ROCKBESTOS PRODUCTS CORP., 452 Nicoll St., New Haven

Please send me.....copies of your report on Socket Heating.

Name.....

Title.....

Company.....

Address.....

KHATHA

The Papuan is a believer in khatha—eating his fallen enemy.

By eating him he believes he acquires the virtues of his victim.

By this act he admits that his enemy has *some* virtues.

It's nice to think that way about an adversary. We of Morganite practice that.

We believe there are more bad applications of brushes than there are bad brushes.

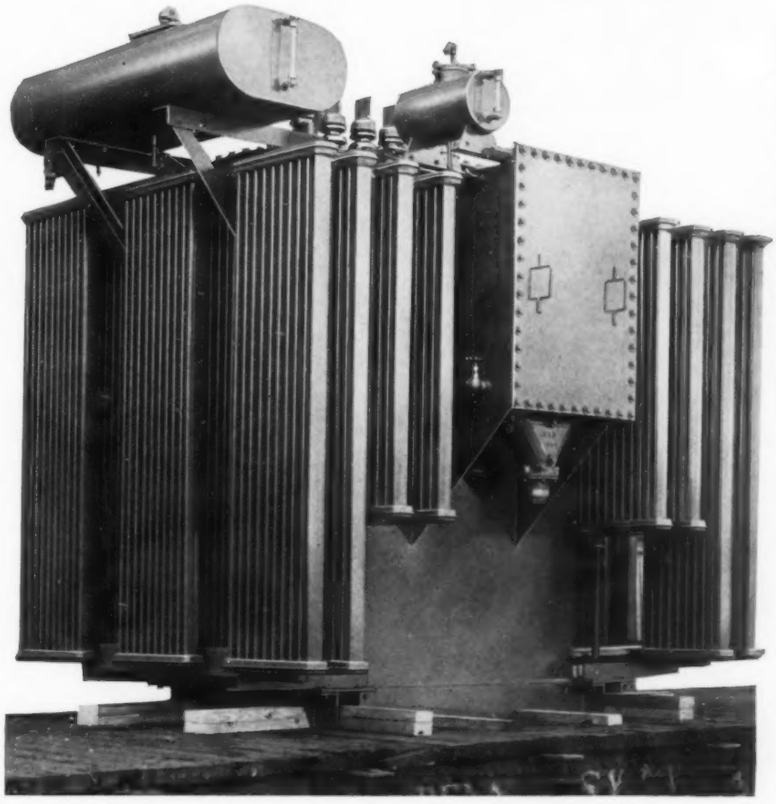
But we also believe that no brush can excel a Morganite brush in *any* virtue.

And we'll not eat those words.

Morganite Brush Co., Inc.

Main Office and Factory
3302-3320 Anable Ave., Long Island City, N. Y.
DISTRICT ENGINEERS AND AGENTS

Pittsburgh, Electrical Engineering & Mfg. Co., 909 Penn Ave.
Cleveland, Electrical Engineering & Mfg. Co., 320 Union Building
Birmingham, Ala., A. J. Bowron, 1210 Watts Building
Revere, Mass., J. F. Drummey, 62 Pleasant Street
Los Angeles, Electrical Engineering Sales Co., 417 So. Hill Street
San Francisco, Electrical Engineering Sales Co., 222 Underwood Bldg.
Toronto, Can., Railway & Power Engineering Corp., Ltd., 171 Eastern Avenue
Montreal, Can., Railway & Power Engineering Corp., Ltd., 3745 St. James Street West
Winnipeg, Can., Railway & Power Engineering Corp., Ltd., P. O. 325



Pennsylvania Heavy Duty Power and Distribution Transformers are logically selected for service where reliability of operation is of paramount importance.

PENNSYLVANIA TRANSFORMER COMPANY

Twenty-Eighth Street and A. V. R. R., Pittsburgh, Pennsylvania

LE CARBONE BRUSHES

AND CARBON PRODUCTS

CAPTURE

that elusive quality for which you have sensed the need

INVESTIGATE

the new range of up-to-date

LE CARBONE PRODUCTS

to overcome your latest troubles and achieve greater economies

WRITE TO OUR NEAREST OFFICE FOR

REAL BRUSH ASSISTANCE

LE CARBONE COMPANY

15th & BLOOMFIELD STREETS HOBOKEN, N. J.

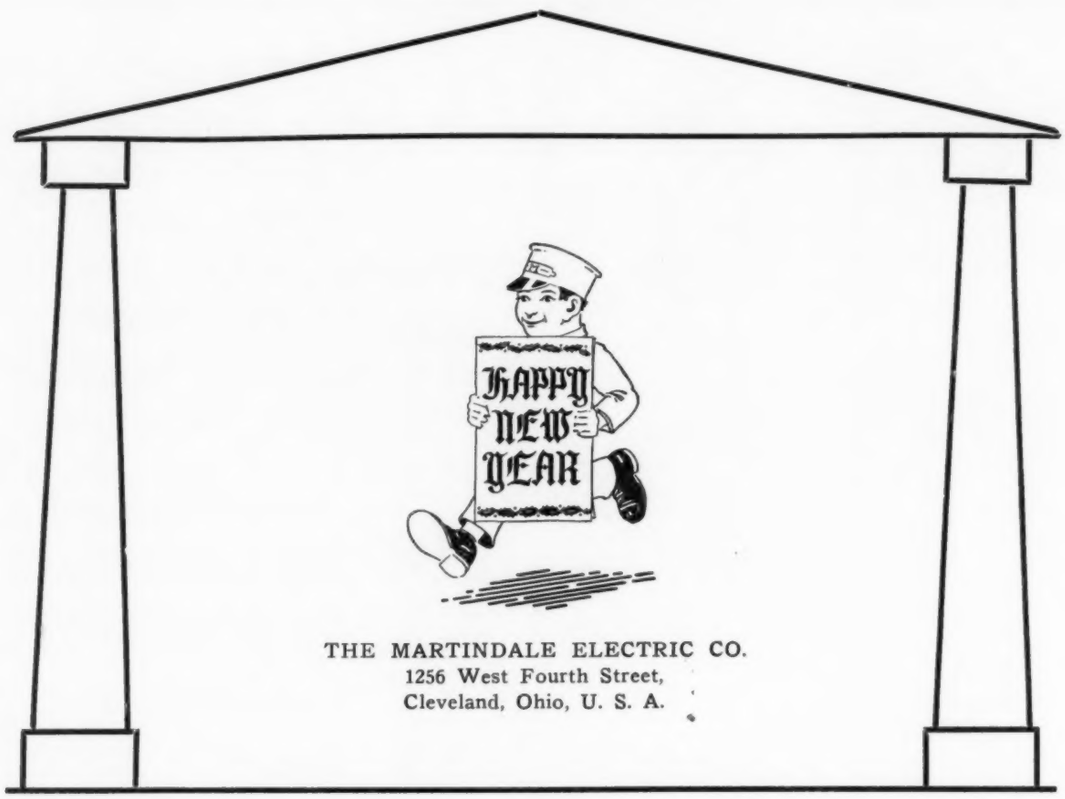
DISTRICT OFFICES

Pittsburgh, Pa.
2882 West Liberty Ave.
South Hills Station

Cleveland, Ohio
4346 W. 60th St.

Chicago, Ill.
53 W. Jackson Blvd.

San Francisco, Calif.
525 Howard St.



THE MARTINDALE ELECTRIC CO.
1256 West Fourth Street,
Cleveland, Ohio, U. S. A.

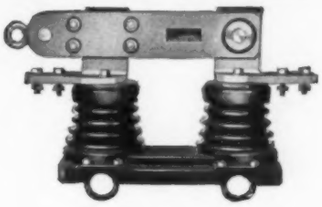
STIMPLE & WARD CO.

INCORPORATED

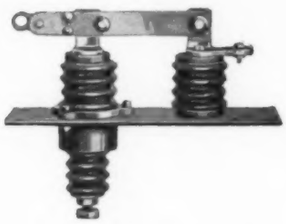
Manufacturers of Very High Grade
Armature and Stator Coils
In All Voltages

PITTSBURGH, PA. — SINCE 1898

SPECIAL EMERGENCY SERVICE



Cat. No. 10497-Z Type U-1
7500 Volts 1200 Amperes



Cat. No. 12583-Z Type W-7
7500 Volts 300 Amperes

SERVICE VALUE

After all, it is the "service value" of electrical equipment that counts and not the original cost. The highest service value can only be obtained from equipment built to withstand the most severe service that can be applied to it. By being well designed by men who know operating conditions, by being constructed of the best materials obtainable and finally, assembled by men who know their job, Three E equipment has service value built into it.

Three E indoor disconnecting switches have numerous features which make them profitable investments in service value. May we send you our Bulletin No. 112 which fully explains these features?

SERVICE VALUE—Low Cost per Year of Service

It pays to use The Three E' Catalogue

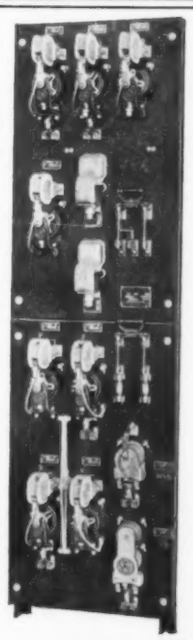
ELECTRICAL ENGINEERS EQUIPMENT CO.

General Offices and Factory:
MELROSE PARK, ILL.

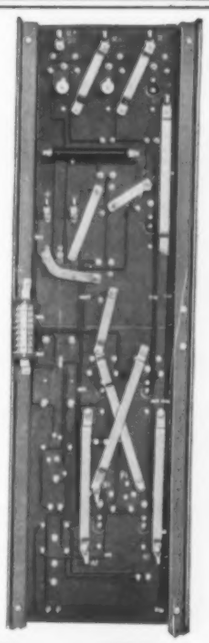
Sales Offices in All Principal Cities

Canadian Representative
Northern Electric Company LIMITED

"THREE E" HIGH QUALITY LINE AND STATION EQUIPMENT



CLARK "3C" MAGNETIC CONTROL



The illustrations show a Clark "3C" Standard Reversing Plugging Type, complete, floor mounted Magnetic Control Panel for direct current steel mill service.

The same standard mounting would be used for plain reversing without plugging; also for non-reversing panels.

This method of mounting lends itself very nicely to the practice of lining up any number of controllers close together to present the appearance of one large switchboard of uniform height with uniform clearance between the floor and the lower edge of all panels.

On these Clark "3C" Controllers **Every Accelerating Contactor is its own Relay.** This is a feature of importance to the Operating Department. It means less electrical contacts for the same required performance. Therefore less time necessary for inspection. It means less chance for something to go wrong electrically, hence fewer possibilities of delay.

In brief, if you specify D.C. Magnetic Controllers wherein **every Accelerating Contactor is its own Relay,** you will save money in the long run.

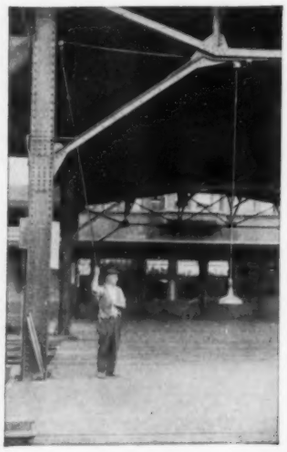
Note the rear view of this Controller. See the reduced amount of small control wiring. How easy it is to trace the circuits. Note the barrier type terminal board for the small wire connections.

THE CLARK CONTROLLER CO.

AKRON, O. CANTON, O. 1146 EAST 152ND ST. NEWARK, N.J. PITTSBURGH
BIRMINGHAM CHICAGO **CLEVELAND, O.** NEW ORLEANS ST. LOUIS
BOSTON CINCINNATI DETROIT MIAMI, FLA. NEW YORK SAN FRANCISCO
BUFFALO DALLAS, TEX. LOS ANGELES MINNEAPOLIS PHILADELPHIA SEATTLE

AGENCY IN CANADA—RAILWAY & POWER ENGINEERING CORPORATION, LIMITED

•OWNING AND OPERATING SUNDH ELECTRIC CO., NEWARK, NEW JERSEY•



For Indoor and Outdoor Use

EASY ACCESS

—promotes frequent cleaning of reflectors

Clean reflectors put more light down in the working area

Thompson Lamp-Maintenance Hangers provide easy access to high lamps, and avoid climbing or electrical hazards.

Safety and **easy accessibility** contribute to maximum results at lowest cost.

Thompson Hangers are inexpensive—they can be installed in your present system—either indoors or out.

Write for Catalog B-29 and full details.

See also Thompson Shock Absorber or Vibration Arrester; prolongs life of costly bulbs. Get our free booklet on protecting lamps from vibration.

The THOMPSON ELECTRIC COMPANY

1438 West Ninth Street CLEVELAND, OHIO, U. S. A.

Depend on USG Brushes

Where uninterrupted service is necessary—you can depend on USG Brushes.

USG Brushes are "tailor made;" the specific application is carefully considered by expert brush engineers before any grade recommendation is made. Once applied, you can depend on them to give long life, perfect commutation and complete satisfaction.

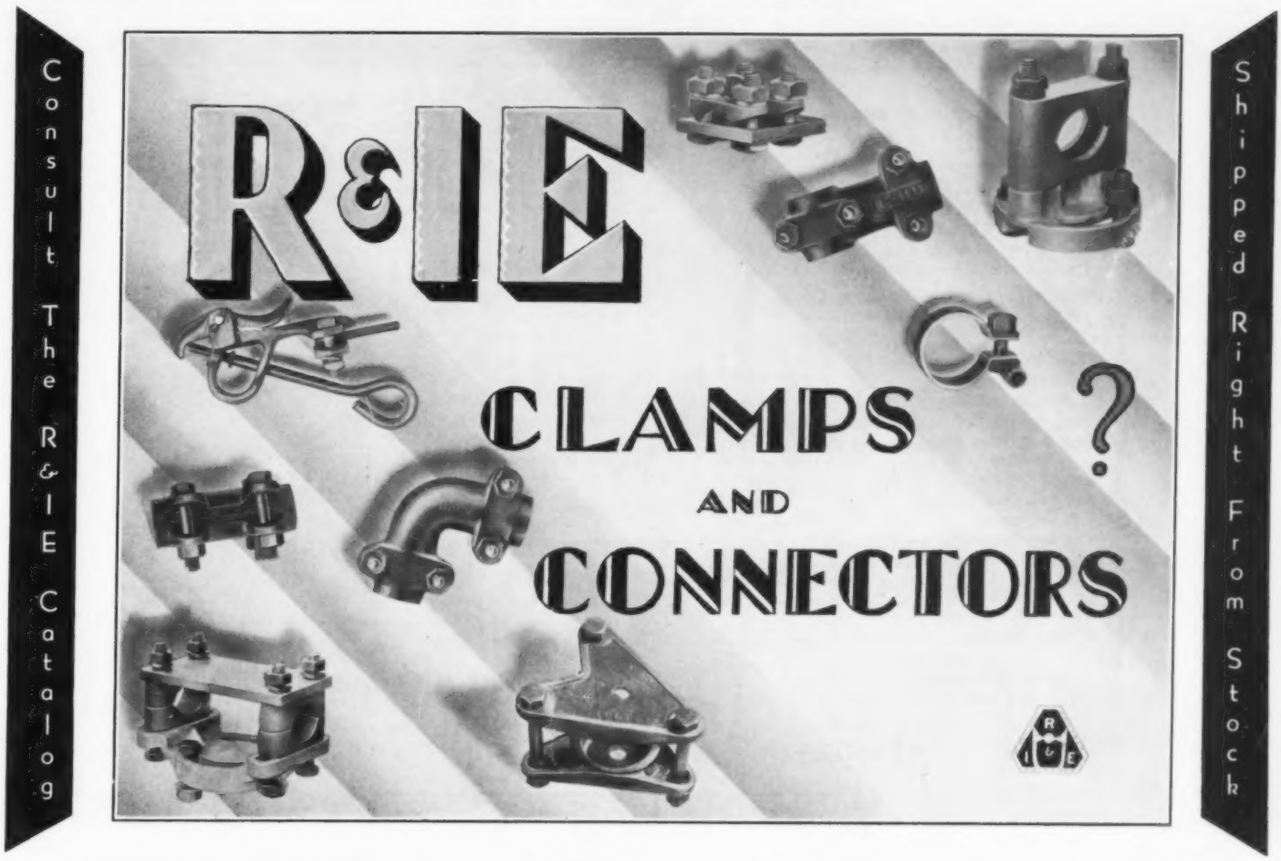
Write for your copy of Catalog B5.

THE UNITED STATES GRAPHITE COMPANY

SAGINAW, MICHIGAN

District Offices

NEW YORK PHILADELPHIA PITTSBURGH CHICAGO ST. LOUIS



RAILWAY AND INDUSTRIAL ENGINEERING CO., GREENSBURG, PA.

REDUCE OUT-OF-SERVICE LOSSES
PREVENT NEEDLESS DELAYS
With the NEW BUSS SUPER-LAG Fuse

THE FUSE BUILT TO PREVENT USELESS SHUTDOWNS AS WELL AS TO PROTECT EQUIPMENT—THE FUSE WITH A TIME-LAG FAR IN EXCESS OF ANY OTHER

Why put up with all the annoyance of fuses blowing needlessly? Why use old time fuses with their short, UNSATISFACTORY time-lag?

Why not use MODERN FUSES? Fuses designed to carry many of those troublesome current surges that occur at all times on all electrical circuits.

You can obtain such a fuse in the NEW BUSS SUPER-LAG Renewable Fuse. Due to the "LAG-PLATES" attached to the BUSS Link it has a time-lag far in excess of anything ever before thought possible. Because of this it will SAFELY HOLD many of those temporary or harmless overloads, heretofore so difficult to control.

Don't be content to put up with all the waste and annoyance of old style fuses. Inform yourself about this latest invention in electrical protection — A MODERN FUSE MADE TO MEET MODERN OPERATING CONDITIONS.

It's These Lag-Plates That Give the Buss Super-Lag Fuse Its Superior Time-Lag.

Standardizing on BUSS SUPER-LAG Fuses means extra profits at the end of the year because of increased operating efficiency and reduced fuse bills. Order them from us. Our complete stock assures prompt service.

DOUBLEDAY-HILL ELECTRIC COMPANY
110-112 SEVENTH STREET PITTSBURGH, PA.

LARGEST BUILDERS OF THE WORLD'S LARGEST CRANES

Alliance Products

STANDARD CRANES
Up to 430 tons capacity

STRIPPING CRANES
Up to 320 tons capacity

COMBINATION CHARGERS and STRIPPERS
Up to 200 tons capacity

- Ladle Cranes
- Ingot Strippers
- Soaking Pit Cranes
- Open Hearth Charging Machines
- Slab and Billet Charging and Drawing Machines
- Gantry Cranes
- Ore and Coal Bridges
- Car Dumpers
- Forging Manipulators
- Steam Drop Forge Hammers
- Coke Pushers, Levelers and Door Lifters
- Coal Pier Equipment
- Rolling Mill Machinery
- Cement Plant Machinery
- Dock Handling Equipment
- Coke Oven Equipment

271 of 100 Tons Capacity and over

LADLE AND STANDARD CRANES

59		100 tons
2	WORM DRIVEN Ladle,	100 tons
2		115 tons
6	WORM DRIVEN Ladle,	125 tons
45		125 tons
30		150 tons
3	WORM DRIVEN Ladle,	150 tons
6	WORM DRIVEN Ladle,	160 tons
2	WORM DRIVEN Ladle,	165 tons
4	WORM DRIVEN Ladle,	175 tons
27		175 tons
3	WORM DRIVEN Ladle,	200 tons
4		200 tons
5		225 tons
1		250 tons
3	WORM DRIVEN Ladle,	250 tons
3	WORM DRIVEN Ladle,	275 tons
1		275 tons
1		300 tons
3		430 tons

STRIPPING CRANES

8		100 tons
1		125 tons
21		150 tons
19		200 tons
1	Single Ram,	320 tons

COMBINATION CHARGERS AND STRIPPERS

3		100 tons
1		125 tons
3		150 tons
4		200 tons

Give Us the Runway and We will Lift the World

THE ALLIANCE MACHINE CO.
ALLIANCE, OHIO, U.S.A.
ENGINEERS AND BUILDERS

POWER SAVINGS AS HIGH AS 25%

with no initial investment

DIXON GRAPHITE ROLL NECK

GREASES HAVE REPEATEDLY REDUCED POWER COSTS. WHY NOT LET US DISCUSS THIS PROPOSITION WITH YOU?

DIXON GREASES CAN BE SUPPLIED TO SUIT YOUR METHOD OF APPLICATION.

Write Now

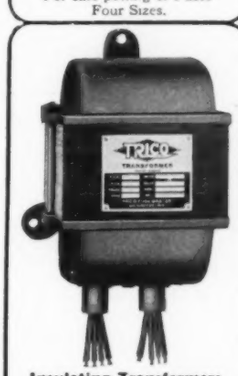
JOSEPH DIXON CRUCIBLE COMPANY

Jersey City, N. J.

TRICO
REG U S PAT OFF

Renewable Fuses
Built-in Money Saving Factors
Fundamentally Correct

Fuse Pullers
For safe pulling of Fuses
Four Sizes.



Insulating Transformers
¼ to 50 K V A
Approved by Underwriters.

Auto Transformers
¼ to 50 K V A.
They're Air-Cooled.

Our Wish

Our sincere wish is that the Christmas holidays bring you an overflowing measure of good cheer; and may the New Year find you at the threshold of increasing prosperity.

OUR PROMISE

We can not let this month slip by without expressing our gratitude to our customers who have contributed their support to our growing business.

While we have a persistent ambition to grow and enlarge, we feel that our permanent success depends on satisfied customers, and that we can not prosper unless we serve you to your advantage.

Thus, we promise to keep faith with you by maintaining a policy that reflects the high standards in material and workmanship; and fair, friendly business relations.

TRICO FUSE MFG. CO., Milwaukee, Wis.

FUSES

Non-Renewable Fuses
Built for Service—not down to a price

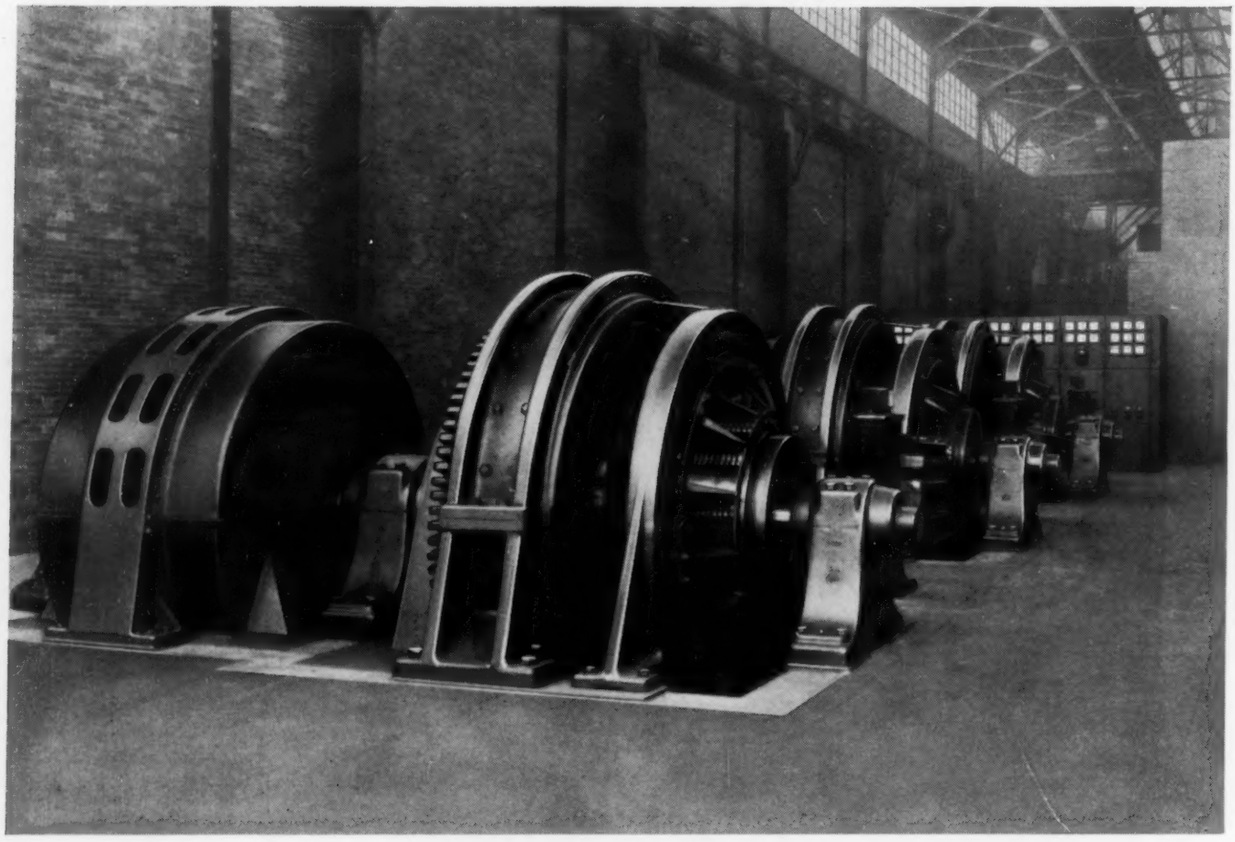
Colortop Plug Fuses
Tells instantly the capacity of a Fuse by its color

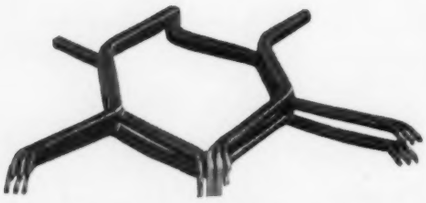
KLIPLOK Clamps
reduce resistance
Preserve Clips and Fuses

KLIPLOK Test Clamps
for accurate testing

KLIPLOK Ground Clamps
assure a positive ground.

Better Performance *with* Frog-Leg Windings





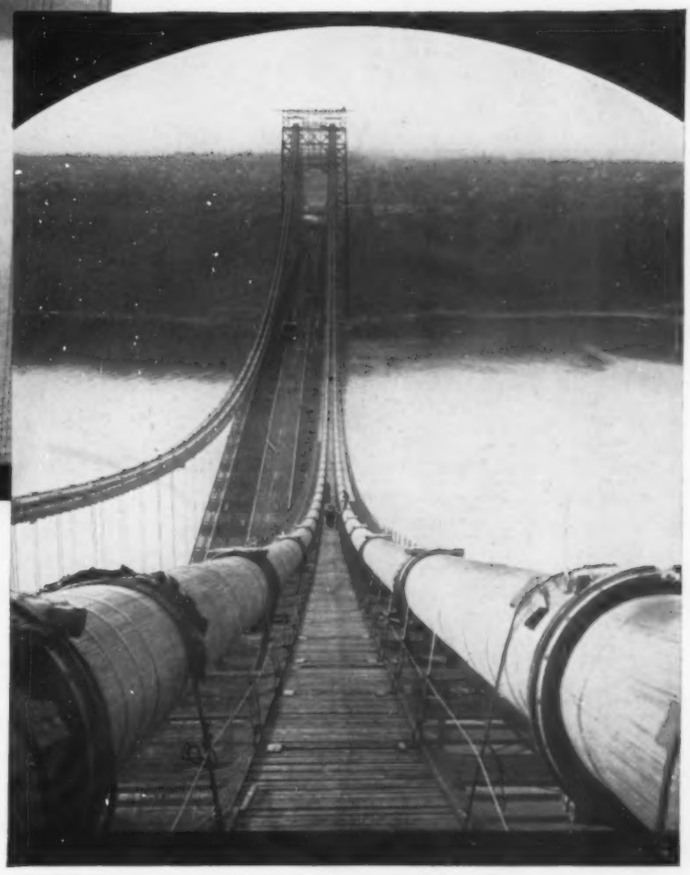
Section of a Frog-Leg winding showing one complete coil and parts of two other coils which occupy the same slots. *This winding is discussed in Leaflet 2135.*

TO furnish power for the mill supply circuit in the plant of a prominent steel manufacturer in the Youngstown, Ohio district, Allis-Chalmers has installed four 1500 kw., 250-volt direct current, 6600-volt, 3 phase, 60 cycle, 514 r.p.m. Synchronous Motor Generator Sets. As is our standard practice, the DC armatures are equipped with Allis-Chalmers Frog-Leg Windings, giving 100% cross connection without the use of external cross-connectors or involute windings. With this complete equalization of equi-potential points, it naturally follows that improved commutation is the direct result.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

ALLIS-CHALMERS

Morgan Rolling Mills are identified with the world's great projects in steel.



The George Washington Memorial Bridge across the Hudson has a span of 3500 feet, nearly twice that of the next longest suspension bridge.

More than 107,000 miles of wire form the four great cables. Each cable is made up of 26,474 wires divided into strands of 434 wires each.

In the rolling of the rods for these wires, John A. Roebling's Sons Company employed their new Morgan continuous rod mill.

Photos by Underwood & Underwood

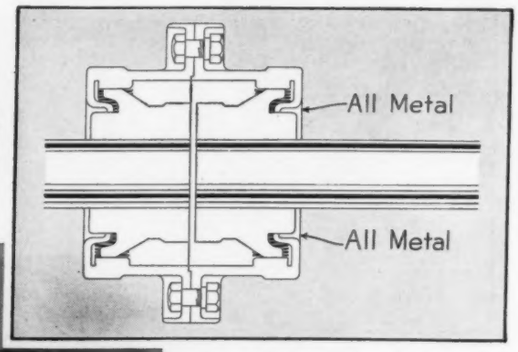
MORGAN CONSTRUCTION COMPANY - - WORCESTER, MASS., U. S. A.

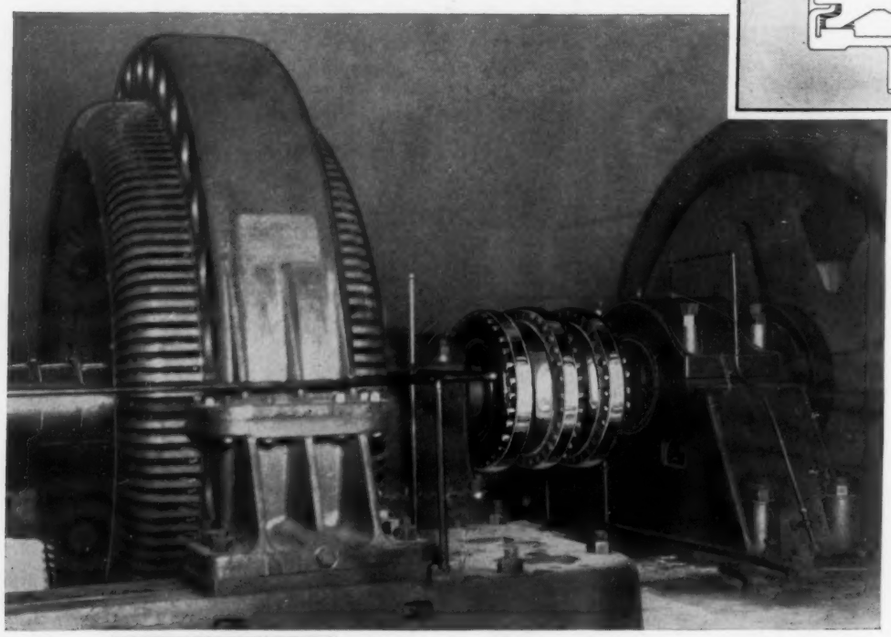
European Representatives—International Construction Company, 56 Kingsway, London, W. C. 2, England
Davy Brothers, Sheffield, England

MORGAN WORCESTER

Engineers and Manufacturers

Dust-Proof and Stays Dust-Proof

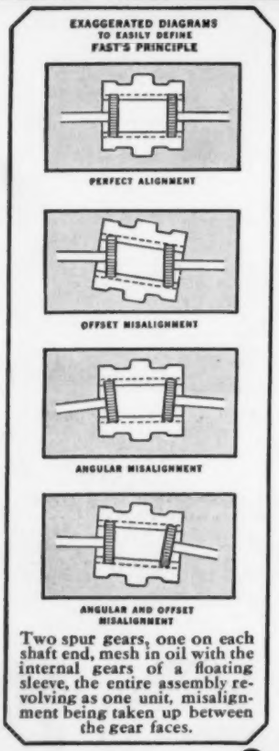




Fast's Heavy Duty Coupling at Pittsburgh Crucible Steel Co., Midland, Pa.

HERE'S WHY

Metal bearing rings on metal hubs. Metal-to-metal bearing seals the coupling permanently—excluding dust, grit, fumes, water, and eliminating this hazard of wear.



Two spur gears, one on each shaft end, mesh in oil with the internal gears of a floating sleeve, the entire assembly revolving as one unit, misalignment being taken up between the gear faces.

ONLY actual metal-to-metal contact can *permanently* seal a coupling against the wearing action of dust, fumes, abrasives, moisture, dirt and grit present in the atmosphere of factories.

See the diagram above. Metal bearing rings on metal hubs. Metal-to-metal bearing seals the coupling. No perishable materials to harden, dry, break-down or let in dust. Fast's patented metal bearing rings seal out dust, fumes, moisture and other machine wearing substances *forever.*

Oil carries the load in Fast's Coupling, cushioning and lubricating between the gear-teeth, and because the oil stays fresh, clean, 100% grit-free, Fast's Coupling gives far longer and more efficient service.

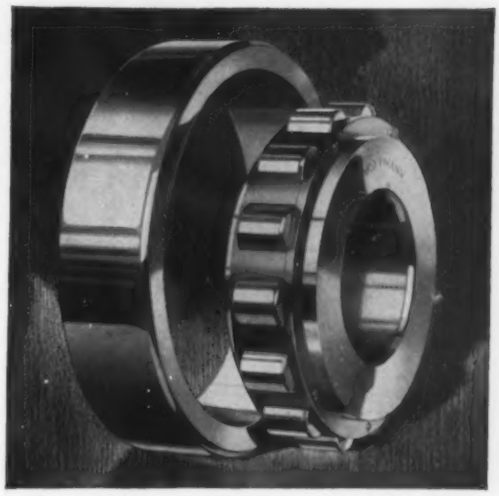
Years of service have proven that Fast's *Self-Aligning* Coupling "lasts as long as the connected machines."

FAST'S *Self-Aligning* COUPLINGS

PERMANENTLY DUST-PROOF

THE BARTLETT HAYWARD CO. ◆ SCOTT & McHENRY STS. ◆ BALTIMORE, MD.

WHERE *no other type of bearing* WILL STAND UP



PARALLEL LINE CONTACT

Solid cylindrical rollers between cylindrical races providing maximum load contact area, increased steady load capacity, and a larger shock-absorbing capacity than any other type of single-row bearing.

SAFETY FACTOR

A margin ample for temporary overloads up to 50% beyond normal rating, as under peak loads, in unusually severe duty, or under shock conditions.

SUPERIOR CAGE

Made of extruded bronze to secure maximum density and uniformity—machined all over for balance—riding on inner ring lands or shoulders, relieving the rolling elements of its weight.

EXTREME ACCURACY

Rollers held to .0001 inch on diameter and to .0002 inch on length, throughout—absolutely true rolling surfaces, ends absolutely square with the sides—highly finished, quiet, friction-free.

DURABILITY

Uniform contact throughout the length of the rollers, providing the most efficient load distribution—greater wear-resisting surfaces—true rolling between all load contact areas—minimum friction between roller and cage.

SPEED QUALITIES

A lower friction coefficient under heavy load than any other type of bearing—a speed ability equal to that of any ball bearing, size for size, up to 35,000 R.P.M.

•

There's no duty too hard for a PRECISION Roller Bearing. And, for the less exacting duties, there are PRECISION Ball and Thrust Bearings. Write for the Catalogs—or ask our engineers for suggestions.

Because of Extreme Load Conditions, Use

PRECISION ROLLER BEARINGS

With the Heavy Bronze Cage

Picture to yourself the most difficult load conditions a bearing can be called upon to meet—high speed, heavy load, temporary overloads, shock, vibration. Then read, in the adjoining column, how NORMA-HOFFMANN Precision Roller Bearings—time-tested heavy-duty units—meet these conditions.

• • •

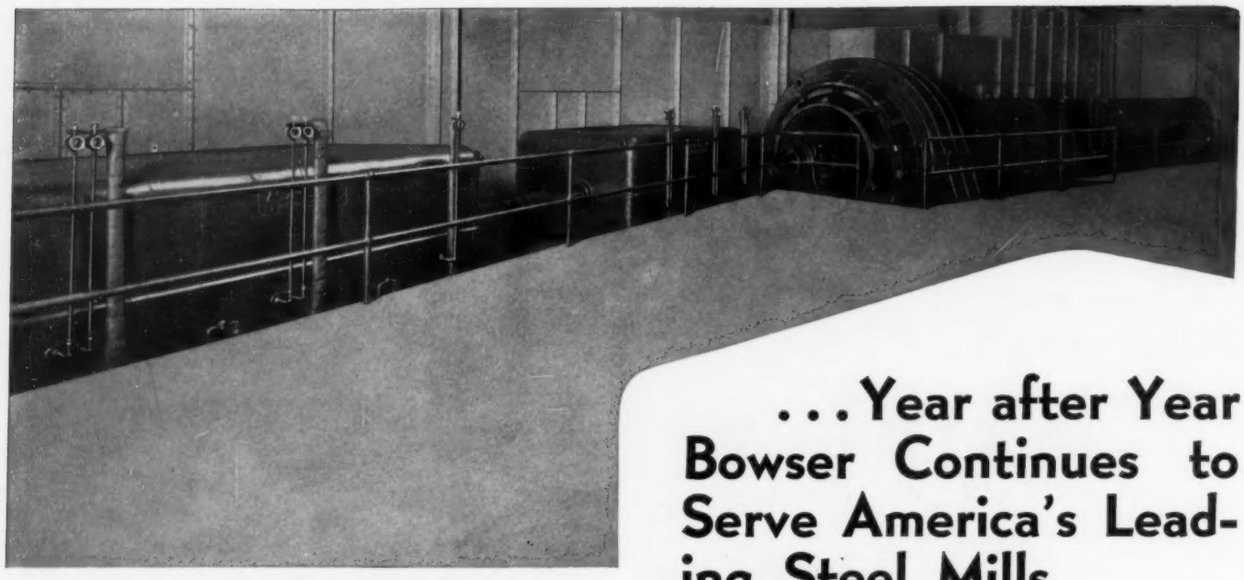
And remember—PRECISION Roller Bearings interchange in size with all standard ball bearings. They can be had—in addition to the standard type here illustrated—in one-lip, two-lip (self-contained), full roller type (without cage), self-aligning and adapter types.

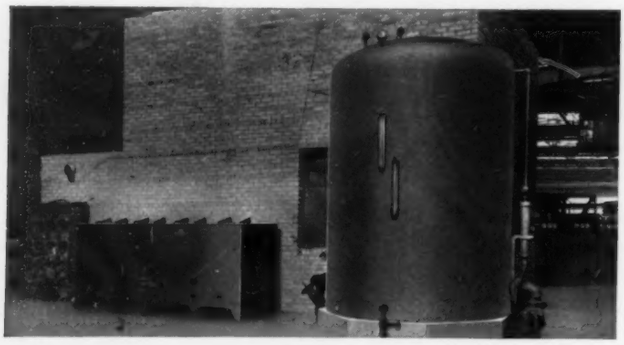
"NORMA-HOFFMANN"

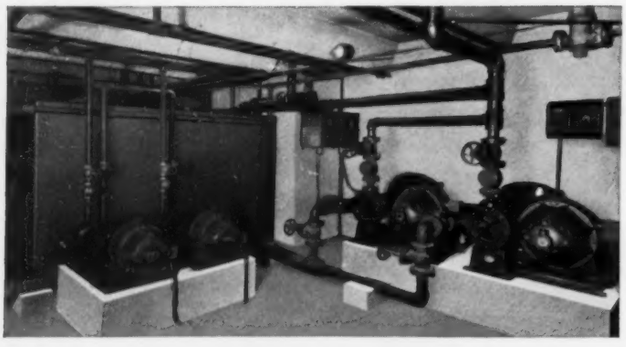
PRECISION BEARINGS

BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.







. . . Year after Year Bowser Continues to Serve America's Leading Steel Mills . . .

with efficient and dependable lubrication and filtration systems, that reduce lubrication costs, prolong equipment life, and minimize repairs and shut-downs.

Day after day, Bowser engineering service proves of value to steel mill engineers because of the many years of practical experience which Bowser engineers have had in studying and solving the wide and varying lubrication problems of individual mills.

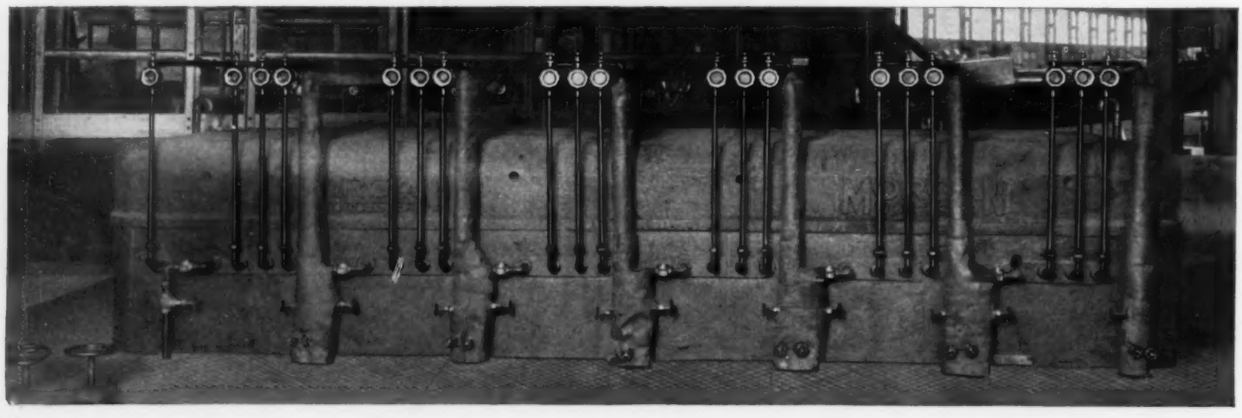
When in need of reliable counsel on any lubrication problem, your selection of Bowser service might well be guided by the experience of the leading steel mills of America.

BOWSER ESTABLISHED 1885

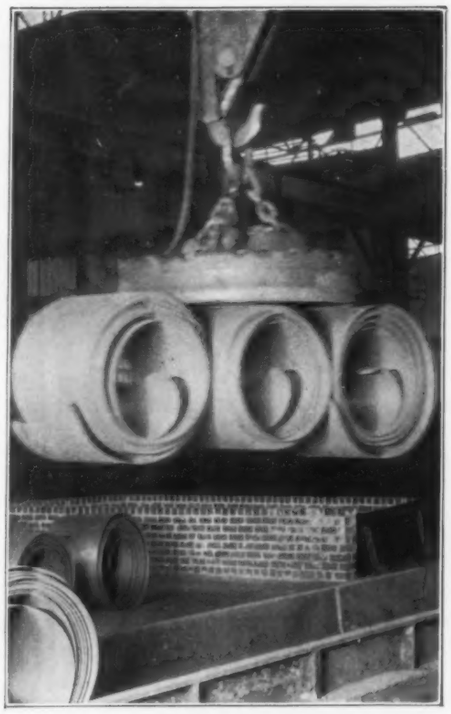
LUBRICATION ENGINEERS AND MANUFACTURERS

S. F. BOWSER & COMPANY, Inc.

1374 Creighton Ave., Fort Wayne, Indiana



OHIO *Reliable* MAGNETS



55" Ohio Round Magnet handling heavy rolls of strip steel

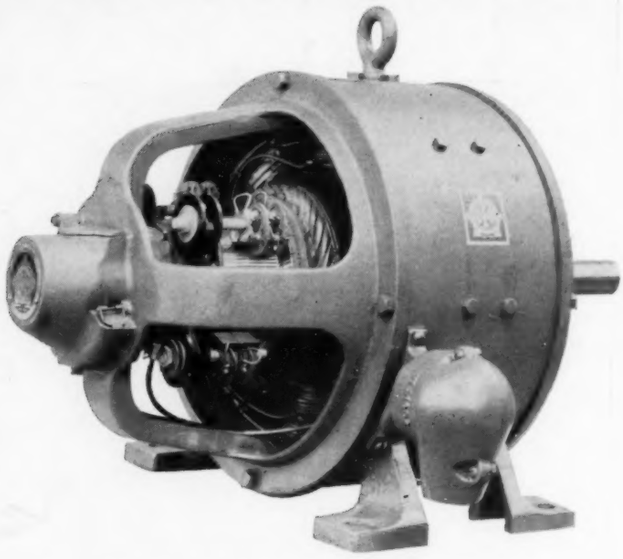
The Bolts used for Ohio Magnets are turned in our factory from 3½% nickel steel (S. A. E. specification No. 2320) and are then carefully heat treated by experts. Such Bolts seldom fail.

This is one more reason why Ohio Magnets are reliable.

THE OHIO ELECTRIC MFG. CO.
5907 Maurice Ave., Cleveland, Ohio

OHIO *Reliable* MAGNETS

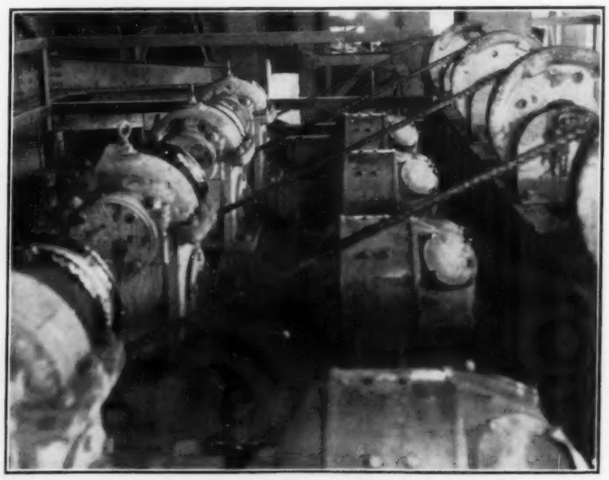
Record-keeping BUYERS CHOOSE *these* MOTORS



The big idea back of these rugged, general-purpose motors is to build a motor which will give more hours of continuous running on steel mill jobs. They embody the ideas of steel-mill engineers who have learned from experience in their own mills how motors must be built to stand the continued hard raps of steel-making.

IT IS easiest to sell Type T Reliance Motors to record-keeping buyers—those who find the reasons for good or bad results. Such men learn the final cost, which is the only correct way to accurately measure value.

Type T Motors have gained a 17-year record for stability of design and dependable service on the maintenance cost sheets of steel mills. Evidence of this is found in a consistent entry of repeat purchases which any Reliance Sales Engineer will show you.



Enclosed, dust-tight Type T Reliance Motors used for opening furnace doors in a steel mill. Maintenance records will show that a premium paid for quality motors on jobs like this is insignificant when spread over months and years of better service.

RELIANCE A-C D-C MOTORS

RELIANCE ELECTRIC AND ENGINEERING CO.
1080 Ivanhoe Road, Cleveland, Ohio
BRANCHES: Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, Milwaukee, New York, Philadelphia, Pittsburgh.

IRON and STEEL ENGINEER

FUEL ELECTRICITY ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907 MACHINERY METHODS

EMPIRE BUILDING, Pittsburgh, Pa.

Established in 1907 as Proceedings of Association of Iron and Steel Electrical Engineers, the Steel Industry's Only Engineering Society.

STEEL MILL STATISTICS

of interest to the

ADVERTISING EXECUTIVE

Prepared By

IRON AND STEEL ENGINEER

THE STEEL MILL ENGINEERING PERIODICAL

Covering

Mechanical, Electrical, Combustion, Lubrication, Safety Engineering and Operating Departments

With Respect To

Selection, Design, Installation, Operation and Maintenance of All Equipment

Used To

Process and Produce Iron and Steel.

PUBLISHED BY

ASSOCIATION OF IRON & STEEL ELECTRICAL ENGINEERS

National Headquarters, 1010 Empire Building, Pittsburgh, Pa.

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ONE DOLLAR PER COPY

STATISTICS—IRON AND STEEL ENGINEER

ESTABLISHED IN 1907

Twenty-eight Engineers of the Iron and Steel Industry conceived the idea of the formation of an engineering society, the transactions of which should record the experiences and opinions of engineers in the operation of Steel Mill Equipment, secured in THE FIELD OF OPERATION.

In twenty-five years 3,960 subjects, which have to do with the Selection, Design, Installation, Operation and Maintenance of Steel Mill Equipment, have been discussed in THE IRON & STEEL ENGINEER.

THE IRON & STEEL ENGINEER may justly claim to be the Leading Engineering Periodical in the Iron and Steel Industry.

The engineering service rendered by THE IRON & STEEL ENGINEER represents the operating experiences of some one thousand mill executives, who are in daily contact with the processing and production of Steel.

PURPOSE OF THE IRON & STEEL ENGINEER

The dissemination of information, covering the Design, Installation, Operation, Maintenance and Selection of Steel Mill Equipment, which is used to process and produce Iron and Steel.

HOW DOES THE IRON & STEEL ENGINEER FUNCTION?

The Mechanical, Lubrication, Combustion, Electrical and Safety Engineers of the Iron and Steel Industry prepare all of the data and information which appears in THE IRON & STEEL ENGINEER. Their opinions and experiences are gained in THE FIELD OF OPERATION.

MANAGEMENT AND PERSONNEL OF THE IRON & STEEL ENGINEER

THE IRON & STEEL ENGINEER is operated and controlled by the various engineering divisions of the Association of Iron & Steel Electrical Engineers, the personnel of which is Presidents, Vice Presidents, General Managers, Operating Superintendents, Electrical, Mechanical, Lubrication, Combustion, Safety Engineers and Master Mechanics of the Iron and Steel Industry.

ANALYSIS OF EDITORIAL PAGES OF THE IRON & STEEL ENGINEER FROM 1924 TO 1931 INCLUSIVE

2,892 Pages of Editorial Matter of interest to Electrical Engineers.
2,400 Pages of Editorial Matter of interest to Mechanical Engineers.
1,046 Pages of Editorial Matter of interest to Combustion Engineers.
149 Pages of Editorial Matter of interest to Lubrication Engineers,
1927-1931.
243 Pages of Editorial Matter of interest to Safety Engineers.
143 Pages of Editorial Matter of interest to Welding Engineers.
128 Pages of Editorial Matter of interest to Material Handling Engineers.
864 Pages of miscellaneous notes in connection with Steel Mill Apparatus.

SPECIAL STUDIES AND FEATURES OF THE IRON & STEEL ENGINEER

THE IRON & STEEL ENGINEER is the only periodical in America that has printed the complete list of all the electrical drives located in the Iron and Steel Industry. This list indicates Horsepower, Speeds, Voltages, Type of Mill, Method of Connection, Date of Installation and Location of Plant. Sixty pages of this type of information was printed 1930-31.

THE IRON & STEEL ENGINEER is the only publication that has printed the studies of The Special Committee on Bearings of The Association of Iron & Steel Electrical Engineers, which covers motors, cranes and rolling mill machinery. One hundred pages of editorial was printed 1930-31.

The only periodical that has printed The Association of Iron & Steel Electrical Engineers' Electric Overhead Traveling Crane Specifications, which are used exclusively by the Iron and Steel Industry and the Crane Builders of the United States. Also, The Association of Iron & Steel Electrical Engineers' Specifications covering Mill Type Motors used in the Iron and Steel Industry. Specifications to cover large AC and DC Main Drive Motors. Questionnaires in connection with Lubrication of Steel Mill Equipment. Studies in connection with Combustion Control Equipment. One hundred fifty-two pages of this type of editorial was printed 1930-31.

THE IRON & STEEL ENGINEER is the only periodical that goes down into the Steel Industry, that prints under the caption of "Discussion" the opinions and experiences of the Engineers in the Iron and Steel Industry in connection with how equipment operates with respect to Design, Installation, Operation, Maintenance and Cost. One hundred fifty-nine pages of this type of editorial was printed 1930-31.

STATISTICS—IRON AND STEEL ENGINEER

WHY THE EXECUTIVES, OPERATING SUPERINTENDENTS AND ENGINEERS IN THE IRON AND STEEL INDUSTRY READ THE IRON & STEEL ENGINEER

THE IRON & STEEL ENGINEER, the leading periodical of the Steel Industry, presented to the Steel Plants in the last twelve months, engineering and operating experiences and opinions prepared by 275 Engineers and Operating Executives who have to do with the Design, Installation, Operation, Selection and Maintenance of Steel Mill Equipment. It required 574 Editorial Pages, which contained 378 Tables, 294 Charts, 750,000 Words, covering 250 engineering and operating subjects.

The ever changing of methods and equipment used to process and produce Steel requires that the Engineers and Operating Superintendents constantly and consistently refer to THE IRON & STEEL ENGINEER in order to keep abreast of the times. This is true today much more so than in the past, since every human effort is made by every Steel Plant in United States to produce a better quality of Steel at a lower price to the consumer.

As a Steel Mill operating guide and reference, THE IRON & STEEL ENGINEER renders a class of engineering service which permits the Industry's Executives the opportunity to study and compare his practices with the performance of other plants.

THE IRON & STEEL ENGINEER is acknowledged by the Steel Industry to be the Authoritative Forum for the exchange of ideas and opinions.

A TYPICAL EXAMPLE OF READER INTEREST 100% IRON & STEEL ENGINEER

One of the most outstanding examples of a 100% Steel Mill Executive subscription for THE IRON & STEEL ENGINEER is presented as follows:

This particular Steel Plant has the following Executives and each one is a paid-up subscriber to THE IRON & STEEL ENGINEER:

1. Vice President
2. General Superintendent
3. Assistant General Superintendent
4. Chief Engineer
5. Mechanical Engineer
6. Electrical Engineer
7. Combustion Engineer
8. Open Hearth Superintendent
9. Chief Draftsman
10. General Master Mechanic
11. Master Mechanic
12. Field Engineer
13. Assistant Electric Engineer
14. Electric Draftsman
15. Mechanical Draftsman
16. Electric Shop Foreman
17. Maintenance Department Foreman
18. Electric Turn Foreman
19. Sub-Station Foreman

ADVICE TO ADVERTISERS, GENERAL SALES MANAGERS WHO DESIRE TO CONTACT, VISIT AND SELL THEIR PRODUCT TO THE IRON & STEEL INDUSTRY

(Continued)

The Steel Industry, as a whole, buys hundreds of millions of dollars worth of supplies each year, a great deal of it being raw material, such as ore, coal and limestone.

In normal times, approximately $125,000,000 is spent each year for equipment and maintenance supplies.

When the Steel Industry decides to build a blast furnace, an open hearth furnace, a rolling mill or a power plant, the Engineers prepare a preliminary estimate which means securing tentative prices on the equipment they intend to use. After the preliminary estimate is made up, final estimates are prepared and are submitted usually to the president of the company with a request for an appropriation to cover the cost of this work. These requests must show, at least, 20% return from the contemplated investment. Recommendations for the purchase of equipment usually must contain two alternates. Specifications for a particular make or type of equipment are usually made up in the engineering department and must have the approval of the operating department head.

The engineering departments constitute the Chief Engineer, Electrical Engineer, Mechanical Engineer, Combustion Engineer and some times, a Lubrication Engineer.

ADVICE TO ADVERTISERS, GENERAL SALES MANAGERS WHO DESIRE TO CONTACT, VISIT AND SELL THEIR PRODUCT TO THE IRON & STEEL INDUSTRY

The Operating Superintendents are usually blast furnace, open hearth, rolling mill and finishing mill.

Equipment, which will cost $1,000 or more, usually requires an appropriation.

When a blast furnace is to be built or relined, or major repairs are to be made, the General Superintendent, his assistant, the Chief Engineer, the Blast Furnace Superintendent are the major key men to be considered, assisted by the Master Mechanic, the Combustion and Electrical Engineer.

In building an open hearth plant, the key men are the General Superintendent, his assistant, the Chief Engineer, the Open Hearth Superintendent, the Master Mechanic, the Combustion Engineer and Electrical Engineer.

The key men in the rolling mills are General Superintendent, his assistant, the Chief Engineer, the Electrical Engineer, the Combustion Engineer, the Rolling Mill Superintendent, the Master Mechanic and the Lubrication Engineer.

In power plant equipment, the key men are the Chief Engineer, the Electrical Engineer, the Combustion Engineer, together with the General Superintendent and his assistant.

When extensive improvement is planned in any Steel Plant, one of the first moves to be made is the collection of all of the available detail data and information which may be in print. This data and information is reviewed very carefully with the idea of finding out how existing operating equipment is performing, its particular geographical location and the costs.

This information in part, at least, may be had on every modern plant in this country in the files of THE IRON & STEEL ENGINEER where instant reference may be had on types of mills, their location, the character of the drive, date of installation, etc., and primary costs.

The next move usually made, is a visit around the various Steel Plants and personal inspection and examination is made of the modern, operating equipment, the type and character of which they are planning to build and install. After the inspection trips are made, reports are made out of what was observed and preliminary drawings are made. The Chief Engineer's office coordinates all of the various department heads recommendations and suggestions. Electrical, Combustion, Lubrication and Mechanical Engineers, together with Operating Superintendents, are constantly visiting and inspecting one another's equipment in order to keep abreast of the times.

A GENERAL IDEA OF 1929 EXPENDITURES IN THE IRON & STEEL INDUSTRY OPERATING AND CONSTRUCTION COSTS

(Continued)

Cost to Operate By-Product Coke Ovens, 1929

Electric Power and Steam Costs	$ 9,299,400
Water	1,268,000
Repairs	4,227,000
Rebuilding Fund	3,381,600
Miscellaneous Costs	18,598,800
Labor at 40 cents per hour	30,857,000

Cost to Produce Pig Iron, Blast Furnaces, 1929

Electric Power	$ 5,072,400
Steam	22,403,100
Water	4,649,700
Repairs	7,185,900
Refractories	1,268,100
Relining Fund	12,681,000
Miscellaneous Work	30,857,100
Department Labor	51,146,700

Cost to Produce Ingots, Open Hearth Furnace, 1929

Electric Power	$ 3,291,025
Steam	1,097,008
Water	2,742,521
Repairs	9,873,077
Refractories	23,585,885
Melting	84,469,666
Moulds and Stools	8,776,069

A GENERAL IDEA OF 1929 EXPENDITURES IN THE IRON & STEEL INDUSTRY OPERATING AND CONSTRUCTION COSTS

Furnace Rebuilding Fund	48,268,381
Miscellaneous	31,813,241
Department Labor at 40 cents per hour	83,921,162

Cost to Bloom and Slab Ingot Production in Bloom and Slab Mills, 1929

Electric Power	$ 9,653,676
Steam	438,803
Water	1,316,409
Repairs	13,164,103
Heating	13,602,907
Roll Fund	1,755,213
Miscellaneous	13,602,907
Department Labor at 40 cents per hour	47,829,577

Construction Work

Approximately $105,000,000 spent for remodeling blast furnaces, building new open hearth plants, additional coke oven capacity and for new rolling mills.

COST OF POWER USED IN THE IRON & STEEL INDUSTRY, 1929

	For	K.W.H. Used	Cost
	Complete By-Product Coke Operation	549,510,000	$4,121,325
	Complete Blast Furnace Operation	594,784,000	5,072,000
	Complete Open Hearth Operation	438,803,464	3,291,925
ROLLING MILLS	Blooms and Slabs	1,007,012,000	9,653,676
	Merchant Bars	375,245,378	3,150,380
	Rails	121,588,931	1,020,801
	Heavy Plates	142,267,986	2,033,966
	Structural Shapes	191,986,266	1,611,825
	Strip Steel	447,075,814	3,753,435
	Sheets and Light Plates	765,881,154	6,429,975
	Black Plate for Tinning	214,664,427	1,809,620
	Rods	131,603,385	1,074,879

NUMBER AND HORSEPOWER OF MAIN DRIVE MOTORS USED TO ROLL STEEL PURCHASED SINCE 1905

No. Purchased and Installed	Horsepower of Each Motor		No. Purchased and Installed	Horsepower of Each Motor
171	300		120	2000
76	350		5	2100
10	375		1	2150
183	400		8	2200
38	450		3	2300
234	500		3	2400
9	550		48	2500
2	575		3	2600
127	600		3	2700
11	650	REPRESENTS	1	2900
42	700	$130,000,000	58	3000
2	720	TO	1	3100
69	750	PURCHASE	4	3200
1	770	AND	3	3250
138	800	INSTALL	21	3500
8	850	MOTORS	4	3600
17	900		2	3750
2	975	Including	28	4000
112	1000	Cable, Conduits,	1	4200
9	1100	Cell Structure,	7	4500
87	1200	Control and	29	5000
26	1250	Switchboards	2	5500
5	1300	Buildings	2	5600
3	1350	Foundations	5	5750
5	1400		14	6000
122	1500		1	6250
32	1600		7	6500
2	1650		1	6700
11	1700		23	7000
6	1750		2	7500
43	1800		5	8000
2	1850		1	9000

WHERE STEEL IS PRODUCED

	Capacity Tons	Produced 1929 Tons
Eastern District	483,100	762,400
Philadelphia	7,863,400	6,331,000
Buffalo	2,839,000	2,207,600
Pittsburgh	16,136,100	14,594,100
Mahoning Valley	7,966,000	6,440,600
Cleveland	7,699,600	5,533,000
Wheeling	3,246,600	2,547,600
Ohio River	1,874,700	1,437,000
Chicago	13,486,800	11,937,100
Birmingham	2,137,000	1,758,100
Colorado to the Coast	1,819,000	1,422,900

CLASSIFICATION OF STEEL PRODUCTS ROLLED 1929

	Capacity Tons	Produced Tons	Percentage of Total Produced
Rails	3,863,600	2,722,138	6.9
Sheared and Universal Plates	6,432,000	5,022,139	11.5
Structural Shapes	5,311,700	4,778,020	9.5
Merchant Bars, Bands and Hoops	16,956,200	8,937,251	30.4
Strip Steel	3,596,700	2,502,793	6.4
Sheets and Light Plates	6,407,200	5,715,531	11.5
Black Plate for Tinning	2,423,300	1,608,640	4.3
Tubular Goods and Seamless	6,582,200	4,322,225	11.8
Wire Rods	4,329,300	3,134,409	7.7
Plain Wire	3,773,600		

TREND OF THE TIMES IN STEEL MILL BUILDING AND REHABILITATION

(Continued)

Blast Furnaces, 500 Tons to 1000 Tons and over.
Size of furnaces being increased means the use of more steel plates, refractories, larger stoves, more steam and electric capacities, installations of modern gas and air systems, modern boiler plants, ore handling equipment, transportation systems, iron and slag handling equipment, water and sewer systems, gas cleaning equipment, the use of every type of instrument to regulate and control every Mechanical, Combustion and Electrical operation.

Open Hearth Plants:
The most important trend in Open Hearth Plants is the improvements in processes which will allow the Steel Industry to produce increased tonnages of quality Steel.

Furnace sizes are being increased to some extent, which means greater hearth area and the introduction of all types of automatic combustion control equipment to promote a more rapid and economical rate of melting; also, which eliminates to a large degree the human element in the application of fuel to the furnaces.

Increased tonnages mean the expenditure for gas lines and equipment, a better quality of refractories, larger ladle cranes, improvements in metal charging equipment, increased electrical and steam capacities, hundreds of combustion control devices and better systems of material handling; improved roofs and back walls.

Rolling Mills:
In 1900 a 34 inch blooming mill, using rolls 28 inches in diameter and rolling a 7000 pound ingot, weighed approximately 350,000 pounds. This included roll and pinion stands with bed plates, spindles and couplings to the driving connection. The mill tables weighed 265,000 pounds and the manipulator 45,000 pounds. Total weight 660,000 pounds.

In a recent installation of a 44 inch blooming mill, the mill proper weighed 1,500,000 pounds, the tables 1,065,000 pounds, the manipulators 1,150,000 pounds. This mill rolls an ingot weighing 16,000 pounds. Total weight 3,715,000 pounds.

This example is an indication of how the Steel Industry is preparing to take care of the future.

Hot Strip Mills, rolling wide metal, are slowly but surely superseding the old style sheet mills. This is due to the advances made in electrical applications to strip mills.
The advances and progress being made in Rolling Mill practices at the present time, indicate that there will be an urgent demand upon the mill builders to produce equipment which will operate automatically. This

TREND OF THE TIMES IN STEEL MILL BUILDING AND REHABILITATION

condition will be brought about through the use of electrical apparatus (principally magnetic control). There are at present mill installations which which operate semi-automatic.

The improvements in rolling mills in the future will necessitate the expenditures of hundreds of millions of dollars for buildings, foundations, furnaces, producers, mixers, soaking pits, cranes, mills, transmission gears, reduction gears, motor drives, auxiliary motor drives, lubrication devices, shears, transportation equipment, water and sewer systems, gas equipment and combustion apparatus.

Power Plants:
Naturally any great expansion in production of Steel requires additional electrical and steam generating stations, the addition of sub-stations and means for the transmission of energy.

This again involves the construction and erection of buildings, boilers and stacks, turbines and their auxiliaries, turbo blowers, piping, switchboards and wiring, water and sewer systems, tracks and cranes.

Modern boiler plants are 450 pounds with 750 degrees superheat.

Steam turbines, 5000 KW to 20,000 KW are being used in the Steel Industry.

A power plant of 5000 KW capacity costs $1,000,000 approximately to build. The Iron and Steel Industry has at least $500,000,000 invested in power plants. At least 35% of this investment is in obsolete equipment, which must be replaced.

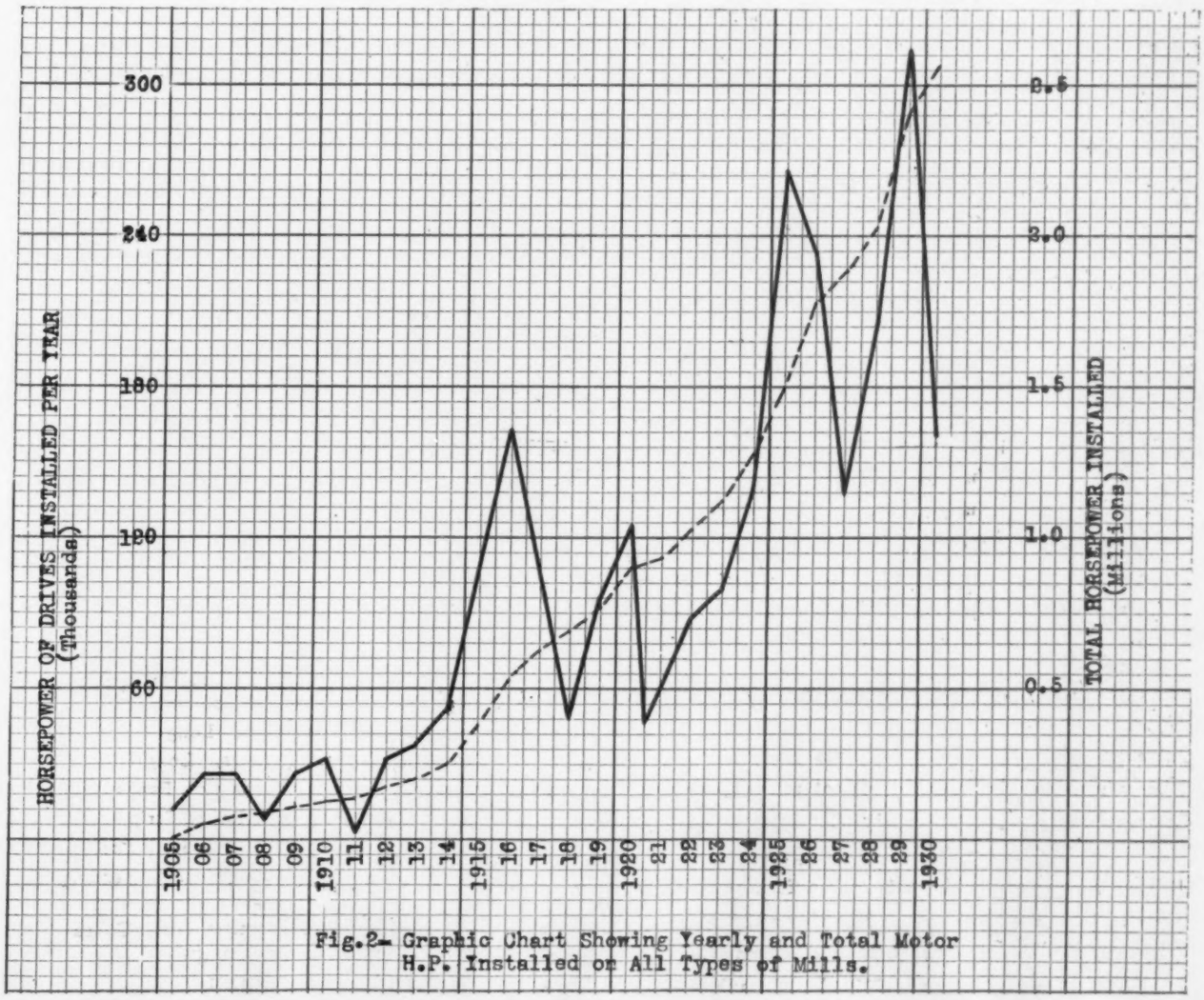

Fig.2- Graphic Chart Showing Yearly and Total Motor H.P. Installed on All Types of Mills.

LOCATION OF STEEL PLANTS

	No. Blast Furnace Plants	No. of Stacks	Steel Ingot Producing Plants	No. Steel Plants
Alabama	17	31	4	7
California			6	7
Colorado	1	5	1	1
Connecticut			4	4
Delaware			2	2
Dist. of Columbia			1	1
Georgia			1	3
Illinois	6	25	11	25
Indiana	3	18	4	22
Iowa			1	1
Kansas				2
Kentucky	4	5	3	9
Maine				1
Maryland	1	6	3	6
Massachusetts	1	1	5	5
Michigan	11	13	3	5
Minnesota	2	3	2	2
Missouri	3	3	3	7
Mississippi	1	1		
New Jersey	3	2	7	15
New York	11	23	12	23
Ohio	37	62	23	91
Pennsylvania	58	107	70	166
Rhode Island			1	2
Tennessee	13	8		2
Texas	1	1	1	1
Utah	1	1	1	1
Virginia	16	13	2	2
Washington			3	2
West Virginia	3	4	7	15
Wisconsin	4	5		6
Canada	7	18	17	27

There are 186 plants having 1,596 Blast Furnace Stoves

There are 182 plants having 910 steam blowers

There are 14 plants having 114 gas blowers

There are 181 plants having 3,080 boilers

There are 47 plants having 11,053 by-product coke ovens

There are 87 plants having 162 converters

There are 90 plants having 112 acid open hearth furnaces

There are 146 plants having 1,120 Basic Open Hearth Furnaces

There are 84 plants having 1,900 gas producers

There are 47 plants having 98 hot metal mixers

There are 118 plants having 318 Cupolas

There are 82 plants with 783 Soaking Pits

There are 427 plants with 7,100 heating furnaces

There are 88 plants with 140 blooming mills

There are 414 plants having 8,600 mill stands

There are 111 plants having 701 pickling tanks

There are 110 plants having 1,095 galvanizing and tinning pots

There are 13,686 electric overhead traveling cranes

There are 1,920 electrically driven main roll drives.

There are 184,000 auxiliary motors

There are 171,000 controllers for motors (not including rheostats)

There are 77,000 instruments used in the Mechanical, Electrical and Combustion Engineering Depts.

There are 576 motor generator sets and rotary convertors over 500 KW.

There is over $600,000,000.00 invested in electrical equipment in the Iron and Steel Industry.

Coke consumed in Blast Furnaces 42,800,000 net tons in 1929

Coal required for coke 62,000,000 tons in 1929

Coal required for Producer Gas 10,000,000 tons in 1929

Fuel Oil for Melting and Heating 871,000,000 gallons in 1929

Tar used for Melting and Heating 461,000,000 gallons in 1929

Coke Oven Gas used 347,000,000 M. Cu. Ft. in 1929

Natural Gas 32,000,000 M. Cu. Ft. in 1929

3466 pounds of coal used to produce each ton of ingots and product therefrom

Ingot Production for 1929, 55,650,000 tons

There are approx. 70 manufacturers of Rolled Steel Billets

32	Sheet Bars—Tin Plate Bars
19	Rails
55	Structural Shapes
34	Wire Rods
42	Universal and Sheared Plates
63	Black Sheets
39	Galvanized Sheets
28	Blue Annealed Sheets
20	Black Plates for Tinning
23	Tin Plate and Terne Plate
38	Muck Bar
130	Merchant Bar
38	Tool and High Speed Steel
12	Horseshoe Bar and Horseshoes
28	Rolled Long Angle Splice Bars, Long Tie Plate
30	Hoops and Bands
22	Hot Rolled Strip
25	Iron and Steel Skelp
24	Wrought Iron and Steel Pipe
17	Seamless Steel Tubes
59	Wire Nails
17	Cut Nails

SELECTING MEDIUMS TO CARRY YOUR MESSAGES TO THE IRON & STEEL INDUSTRY

In selecting the trade or engineering medium to carry your messages to the Iron and Steel Industry it is suggested that the following be kept in mind.

The key men in the Iron and Steel Industry are interested to a large degree in those mediums who cater exclusively to their Industry.

Mediums which lay claim to a coverage of all industries are usually not able to satisfy or interest highly specialized operators due to the fact that their editorial matter is of too broad a nature. Mediums today to be read and analyzed by the Operating Superintendents and Engineers in the Iron and Steel Industry must offer and render a real Engineering Service covering the problems peculiar to this Industry.

To our knowledge there is no one medium in the United States today which may claim a complete service to the Iron and Steel Industry. There are, however, a number of good mediums rendering a partial service to the Steel Industry, each one having its own special appeal, but none, however, are complete.

The Iron and Steel Engineer in the general scheme of things renders exclusively an engineering service to the Iron and Steel Industry in electrical, mechanical, combustion, lubrication and safety subjects.

Circulation figures are often presented by enthusiastic representatives of various periodicals which are often misleading. The key men in the Iron and Steel Industry, particularly the engineers and operators are not to be measured in numbers, for example, ten of the leading steel companies who produce the bulk of the steel and its finished products would not have over a total of two hundred and fifty key men, that would specify or requisition apparatus or supplies for the construction and maintenance of the equipment in their respective plants. Again, there are one hundred and fifty electrical engineers in the Iron and Steel Industry who specify the majority of the electrical products purchased.

Is it not reasonable then to suppose in view of the statistics presented that the greatest objective to be attained in the Iron and Steel Industry is the reaching of the key man, the man who specifies.

To the General Sales Manager, to the Advertising Manager, to the Advertising Agencies, and to all those whom the responsibility is entrusted of marketing the products of your company, the Iron and Steel Engineer offers the following information and data which will be of use to you in placing and executing a sales promotion campaign, through messages in trade mediums, through personal calls on the customer, through direct by mail campaigns and through the distribution of trade literature and catalogues.

The Iron and Steel Industry (proper) producing and finishing plant numbers approximately 463 located in 22 states, 357 plants are located in eight states.

The largest steel centers are located in, or adjacent to

Pittsburgh
Youngstown
Cleveland
Chicago
Birmingham
Wheeling
Middletown
Buffalo
Bethlehem

The eleven leading companies of the United States producing steel are:

United States Steel Corporation
Bethlehem Steel Corporation
Youngstown Sheet & Tube Company
Jones & Laughlin Steel Corporation
Republic Steel Corporation
American Rolling Mills Company
National Steel Corporation
Inland Steel Company
Wheeling Steel Corporation
Colorado Fuel & Iron Company
Crucible Steel Company of America.

The key men in the Iron and Steel Industry are the:

General Managers who must approve all requisitions,

Blast Furnace Superintendents, who specify and make up requisitions,

Open Hearth Superintendents, who specify and make up requisitions,

By Product Superintendents, who specify and make up requisitions,

Converting Mill Superintendents, who specify and make up requisitions,

Rolling Mill Superintendents, who specify and make up requisitions,

Electrical Engineers and Electrical Superintendents, who specify and make up requisitions,

Mechanical Engineers or Master Mechanics, who specify and make up requisitions,

Lubrication Engineers who specify and make up requisitions.

Combustion Engineers, or Steam Engineers, who specify and make up requisitions,

Chief Engineers, who approve requisitions, particularly under what is known as appropriations for new construction and new work,

Purchasing Agents, who as a rule purchase the apparatus and supplies recommended by the plants.

Statistics covering the Iron and Steel Industry may be found in the monthly issues of the Iron and Steel Engineer, particularly the January number. Also statistics indicating the potential markets for various products will be furnished on request.

REPRESENTATIVE USI THE IRON AND YEAR

A

Aetna Standard Engr. Company
Ajax Electrothermic Corp.
Alliance Machine Company
Allis Chalmers Mfg. Company
Aluminum Company of America
American Air Filter Company, Inc.
American Heat Economy Bureau, Inc.
Appleton Electric Company
Automatic Reclosing Circuit Breaker Co.

B

Bailey Meter Company
Baker Raulang Company
Bantam Ball Bearing Company
Bartlett Hayward Company
Benjamin Electric Mfg. Company
E. W. Bliss Company
S. F. Bowser & Company, Inc.
Bristol Company
Brown Instrument Company
Bull Dog Electric Products Company

C

Century Electric Company
Champion Switch Company
Clark Controller Company
Cleveland Crane & Engineering Company
Cleveland Switchboard Company
Colt's Patent Fire Arms Mfg. Company
Combustion Engineering Corporation
Crocker Wheeler Electric Mfg. Company
Crouse Hinds Company
Cutler Hammer, Inc.

D

De Laval Steam Turbine Company
Delta Star Electric Company
Joseph Dixon Crucible Company
Doubleday-Hill Electric Company
Duquesne Light Company

E

Electric Controller & Mfg. Company
Electric Furnace Company
Electric Machinery Mfg. Company

E

Electrical Engineers Equipment Company
Electric Power Equipment Corp.
Electric Service Supplies Company
Electro Dynamic Company
Elliott Company
Erie Malleable Iron Company
Erie Steel Construction Company
Esterline-Angus Company

F

Farrell Birmingham Company, Inc.
Follansbee Brothers Co.
Freyn Engineering Company

G

General Devices & Fittings Company
General Electric Company
J. Guy Griffith Company

H

Harnischfeger Corporation
Hills-McCanna Company
Hodson Corporation
Holophane Company, Inc.
Hyatt Roller Bearing Company

I

Ideal Commutator Dresser Company
Iron City Electric Company
ITE Circuit Breaker Company

J

Jefferson Electric Company
Jewell Electrical Instrument Corp.

K

Keystone Lubricating Company

MANUFACTURERS
N G
STEEL ENGINEER
1931

L

Le Carbone Company
Leeds & Northrup Company
Lincoln Electric Company
Lubrication Devices, Inc.

M

Mantle Engineering Company
Manning, Maxwell & Moore, Inc.
Martindale Electric Company
Mesta Machine Company
Moloney Electric Company
Monitor Controller Company
Morgan Construction Company
Morgan Engineering Company
Morganite Brush Company, Inc.

N

National Carbon Company, Inc.
New Departure Mfg. Company
Nichols Lintern Company
Norma Hoffman Bearings Corporation

O

Ohio Electric Mfg. Company
Okonite Company
Ohio Steel Foundry Company

P

Penn Machine Company
Pennsylvania Lubricating Company
Pennsylvania Transformer Company
Penn Union Electric Corporation
Pittsburgh Electric & Machine Works
William B. Pollock Company
Pyle National Company

R

Railway & Industrial Engineering Company
Reliance Electric & Engineering Company
Republic Flow Meters Company
Robinson Ventilating Company

R

Rockbestos Products Corporation
Roller Bearing Company of America
Roller Smith Company
Rollway Bearings Company, Inc.
Rowan Controller Company

S

Schloemann Engineering Company
Shallcross Control Systems Company
Shepard Niles Crane & Hoist Corporation
SKF Industries, Inc.
Stackpole Carbon Company
Steel & Tubes, Inc.
Stimple & Ward Company, Inc.
Sundh Electric Company
Surface Combustion Corporation

T

Texas Company
Thompson Electric Company
Timken Roller Bearing Company
Tool Steel Gear & Pinion Company
Trico Fuse Mfg. Company
Trumbull Electric Mfg. Company
Turner Engineering Co.

U

Union Carbide & Carbon Corp.
United States Graphite Company
United Engineering & Foundry Company
R. E. Uptegraff Mfg. Company

W

Wellman Engineering Company
Westinghouse Elec. & Mfg. Company
Weston Electrical Instrument Corporation
Geo. D. Whitcomb Company
Edwin L. Wiegand Company

STATISTICS—IRON AND STEEL ENGINEER

Pertinent Facts About the

IRON AND STEEL ENGINEER

Owned, Controlled, Operated, Edited by
The Steel Industry's only Engineering Society,

The Association of Iron and Steel Electrical Engineers

Recognized by the Executives, Operators and Engineers of the Iron and Steel Industry as the Engineering Authority of this Industry.

Twenty-five years of engineering service, rendered to the Iron and Steel Industry.

Is used by the Iron and Steel Industry as a guide for every-day problems, and as a reference when planning new installations.

The Iron and Steel Engineer is the only medium serving the Iron and Steel Industry in which appears the individual engineering opinions of the actual operators of equipment. During the year 1930 two hundred and seventy-five Engineers expressed their opinions regarding equipment, methods, processes, costs, organizations. Their opinions included two hundred and ninety-four charts and curves, also three hundred and seventy-eight tables.

Circulation

The Iron and Steel Engineer is issued regularly the 20th of each month to 2100 persons who are interested in Steel Mill Engineering Practices.

No effort is made to build up the circulation of numbers; only those who have to do with the selection, design, installation, operation and maintenance of equipment are solicited.

No premiums are offered, no reduced rates, no club offers, no circulation "pluggers" are countenanced—the Iron and Steel Engineer reaches its ultimate destination on the part of the subscribers only.

On the above basis our circulation reaches the following:

Presidents, Vice Presidents, Managers and General Superintendents	245
Designing, Lubrication, Chief Engineers and Master Mechanics	281
Combustion Engineers	112
Electrical Engineers	548
Electrical Superintendents	456
Mechanical and Electrical Maintenance Supervisors	411
Miscellaneous	32
Foreign	83
Total	2168

A recent survey of the reader circulation developed the information that the average number of readers of The Iron and Steel Engineer per subscription were 4.1.

MECHANICAL DATA

Trim size of magazine	9 "x12"
Type size of editorial page	7¼"x10"
Columns per page	2
Size of Column	3½"x10"
Type size of advertising page	7 "x10"
Dimensions of wide half page	5 "x 7"
Dimensions of long half page	3½"x10"
Grade of paper	Enamel
Screen best suited for half tones	120
Last form closes 3rd of month.	
Insert Specifications—100 lb. Enamel—Type Page—7"x10"—Stock Size	9½"x12½"

ADVERTISING RATES FOR THE YEAR 1932

12 Pages or More During Year	$ 50.00 Per Page
6 Pages or More During Year	55.00 Per Page
1 Page, Single Insertion	75.00 Per Page
1 Additional Color	20.00 Extra
12 Half Pages or More During Year	35.00 Per Half Page
6 Half Pages or More During Year	37.50 Per Half Page
1 Half Page, Single Insertion	45.00 Per Half Page
Front Cover	250.00 Per Issue
Inside Front Cover	100.00 Per Issue
Inside Back Cover	100.00 Per Issue
Outside Back Cover	100.00 Per Issue
Other Preferred Positions on Request	

No discounts nor commissions excepting 1% for 10 days, net 30 days.